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ABSTRACT

This guide for school administrators and staff is intended to be used in conjunction with the "Guidelines To Provide Uniform Wiring Service for Telecommunications in North Carolina Public Schools" as they: begin planning for cable implementation in the schools; work with architects and builders in the design and implementation of cabling systems; endeavor to match instructional and administrative activities with the telecommunications structures they are creating; and manage these systems over the long-term. The guide is divided into five sections: (1) Purpose; (2) Planning/Implementation (overview/getting started, people involved, general statutes governing, and chronology); (3) Cable Design, Implementation and Use (introduction, key features, structure, cabling design phases, and cable management); (4) Matching Instructional/Administrative Activities with Telecommunications Structure (generic examples for telecommunications and for television, case studies, and common questions and answers); and (5) Diagrams and Appendices (a glossary, a computer facility planning guide, Television Allocations Study Organization (TASO) picture quality descriptions, channel designations and transmitter locations for the University of North Carolina Center for Public Television (UNCCPTV), and local area network (LAN) configuration diagrams). (Contains 33 references.) (ALF)

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A Primer

on Cabling Design and Implementation:

CONSIDERATIONS FOR DECISION-MAKERS

North Carolina Department of
Public Instruction
Bob Etheridge, Superintendent
May 1992

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PURPOSE

The purpose of this document is to provide school administrators with general information on cabling design and implementation in school facilities for instructional and administrative uses — today and tomorrow. The document is to be used in conjunction with *Guidelines to Provide Uniform Wiring Service for Telecommunications in North Carolina Public Schools*, previously distributed to Local Education Agencies.

While the intended audience for the *Guidelines* was primarily the architects and builders who work with school personnel on building renovation and construction, this *Primer* is designed for the school staff itself as they begin initial planning for cable implementation in their schools; work with architects and builders in design and implementation of cabling systems; endeavor to match instructional and administrative activities with the telecommunications structures they are creating; and finally manage these systems over the long-term.

As with the *Guidelines*, telecommunications is used here in its broadest sense — the use of technology to convey aural and visual information and data from one location to another, either within the same facility or among facilities.

Finally, the reader is reminded that the scope of this document cannot, obviously, cover every individual circumstance. However, the intent is to provide general direction for school administrators in their capacity as overseer of school renovation or construction. A list of contacts at the Department of Public Instruction is provided for assistance with individual needs:

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••••Overview/Getting Started••••

When a decision is made to build a new school, add new facilities to an existing school or do a major renovation, many people become involved in the process. These people initially form a planning team that will eventually work with the "construction team."

The beginning agenda for the team is: go see what is available. Go see what telecommunications systems are being used in other places. Discuss the merits of the system with the principal, teachers, media and technology professionals, and students. Record the strengths and weaknesses of the system and its applications. Develop a "feel" for what might be desired.

Next, talk to salespeople, manufacturers' representatives and appropriate engineers. Keep in mind that no two manufacturers may achieve similar functions in a similar way. If possible, talk with non-school related people who have installed similar systems or system components in their businesses, organizations or institutions. Arrange for meetings and demonstrations. Keep meticulous notes — write down everything. Study and discuss all the literature. Then begin to formulate characteristics of a desirable system.

The next step is to do the entire process again. This time there should be a basis for intelligent questions. This is the time for checking details and relationships. The data from the second trip through the process is used to "flesh out" the diagram and redraft the description. Distribute this information to all the potential users of the system. After a reasonable period of time, call for comments, questions and reactions. Another trip through the process may be necessary before a final description can be drafted.

The final description — the educational specifications — should be for the entire system as desired. Furthermore, it should be open-ended so as not to lock out newer technological developments. This is very important, especially for new construction and renovations. For instance, all system components must be connected with conductors. Plan to use the most common conductor — copper. It requires the most space — conduit space. There must be sufficient conduit space (including wireways) to handle all the necessary conductors for the full system. If there is sufficient conduit space for copper, there will be ample space for optical fiber.

A full system may not be economically feasible right now. Most telecommunications systems can be installed in phases. Just be sure that economic feasibility is not translated into an obsolete, dead-end system.

Many educators fail to recognize opportunities to move toward more sophisticated telecommunication applications, such as those possible with an integrated communications system. For instance, when the decision has been made to replace the old intercom/PA system, investigate a voice/intercom system. Don't end up with a speaker box on the wall and an All-Call switch in the principal's office. When the decision has been made to install a television distribution system, install a system that is compatible with an integrated system. When the decision has been made to connect several computers together, look into the possibility of a local area network (LAN) that can serve more than one function for the school. Perhaps now — before any long range decision is made — it is the time

for the planning team to prepare the educational specifications. The proposal prepared by the planning team is then used by the construction team.

••••People Involved••••

The construction team includes the owner; the design team of architects, engineers; contractors and vendors. Each has a significant role on the construction team. As in a three-legged stool, each of the three segments of the construction team has to uphold its share of the responsibility in order to have a project satisfactorily completed. The following are definitions and descriptions of the responsibilities of each member of the construction team. This team is involved from inception to occupancy, and even beyond.

OWNER - The owner in our situation includes the local Board of Education, the superintendent, the planning team, and anyone else on the superintendent's staff that may be assigned to the project. Various sections of the N. C. Department of Public Instruction, when requested, work on behalf of the owner. Building code officials on the state and local levels work in behalf of the owner.

DESIGN TEAM - Architects and engineers are the main players of the design team. However, School Planning (and others such as Child Nutrition, Media and Technology, and Transportation) works very closely with the design team and the owner during all phases of the project. The design team provides the plans and specifications for the structure, including the interior and exterior finishes, the plumbing, the heating and air conditioning and electrical systems, including the lighting and telecommunications equipment. In the absence of municipal (or other district) services for water and sewer, the engineers of the design team will design the on-site services for approval by the Department of Environmental, Health and Natural Resources (DEHNR). Erosion control plans designed by the engineers are reviewed by DEHNR for approval also.

CONTRACTORS AND VENDORS - The actual construction of a project is based on approved plans and specifications followed by the various contractors and subcontractors. Subcontractors are directly responsible to the contractors in most projects. The vendors include the manufacturers and suppliers that make the equipment and materials used in the construction and the furnishings placed within the building. The vendors supply equipment and material which meet the specifications written by the architects and engineers and approved by them.

••••General Statutes Governing••••

Several general statutes regulate the actions of the construction team. Some of them apply to individual members of the construction team and others apply to all of them collectively and individually. They are as follows:

- Owner selection of architects and engineers is covered by General Statute 143-64.31, 32 and 33.

- The owner cannot spend any money for the construction of the project until approved by the State Superintendent of Public Instruction. This is determined through General Statute 115C-521, 522 and 523. Reference is also made to 115C-276.

- Architects are regulated under General Statute 83A.
- Engineers are regulated under General Statute 89C.
- Contractors are regulated under General Statute 87.
- Vendors are regulated under General Statute 133-2 and 3.
- The entire construction team collectively is regulated through General Statute 133-1 through 4, General Statute 129 and General Statute 143-128 through 134. Copies of these General Statutes are available through the Division of School Facility Services, School Planning Section.
- Approval by the Department of Insurance is regulated by General Statute 58-153.

There is frequent contact among members of the construction team. The owner, architect and engineers meet frequently during the programming, planning and design stages. They may meet with various vendors to determine the availability of materials and equipment and learn of the latest technology involved with the materials and equipment. Throughout the design stages the owner, architect and engineers and School Planning should meet frequently to assure a smooth transition into the construction phase. Input from other sections of the Department of Public Instruction is welcomed and encouraged.

••••Chronology••••

A logical sequence of events should govern during a construction project. The following is the recommended chronology of such a project. The General Statutes are referenced where applicable.

1. School system prepares the educational specifications. Involve principals, teachers, media and technology professionals, PTA members and administrative staff. Staff of the Department of Public Instruction, including School Planning, may assist when requested by the local school system.

2. As required by General Statute 133-1.1, hire a design team of architects and engineers. The method of selecting architects and engineers is covered in General Statute 143-64.31, 32 and 33. The design team may be involved in step 1, which could provide better continuity on the project.

3. Design team prepares schematics and the outline specifications based on information contained in the educational specifications. The design team and local school system personnel should discuss these schematics and outline specifications with School Planning, Child Nutrition, Media and Technology, and Transportation. (See "Overview" in this section.)

4. Design team prepares the design development stage of the plans. This stage will determine the overall concepts of construction such as the types of materials for the building, the heating and air conditioning system, lighting and power, kitchen equipment, emergency

power, communications, security, fire alarm, television and computer needs. The design team and local school personnel should review this phase of the project with:

- School Planning,
- Child Nutrition,
- Media and Technology,
- Transportation,
- and Management Information Systems.

5. The design team prepares construction documents, plans and specifications for the entire project as required in General Statute 133. A review with School Planning and the local school system personnel should be done for this phase of the project.

6. General Statute 115C-521 requires that any new construction project be approved by the State Superintendent of Public Instruction. Prior to approval by the State Superintendent, several other approvals must be obtained. The Department of Insurance is required by General Statute 58-153 to provide approval. The Department of Environmental, Health and Natural Resources must provide approvals on the project where on-site water and sewage disposal systems are installed as well as approving a soil erosion prevention plan. These approvals must be obtained prior to the beginning of the construction phase.

7. As required by General Statute 129, the project must be advertised for bids for at least a seven day period of time prior to receipt of the bids. The advertisement should not occur until all approvals required in step six are received.

8. The bids from all contractors are reviewed. The bids from the lowest responsible contractors are accepted, contracts signed, building permits purchased and construction begins. At least three bids should be received for each discipline such as electrical, plumbing, heating/air conditioning and general construction. Single prime contracts are allowed.

9. During the construction phase the owner and the design team make frequent observations of the construction progress. Meetings of the construction team are held regularly to assess the quality of construction and review the time schedule. Resolutions to problems which have occurred are covered and corrected as soon as possible. When required, change orders are made to alter the original contract as necessary. The ideal situation would be for no change orders to occur, but this rarely happens.

10. Upon completion of the construction, inspections are held involving the owner, the contractors, the design team and School Planning when requested. The owner should not accept the building until Certificates of Compliance are provided by the design team members. This is required by General Statute 133-1.1.

CABLE DESIGN, IMPLEMENTATION AND USE

This section provides greater background and detail on building cabling, which is implicit in the activities described in steps 4 and 5 of the chronology presented in the "Planning/Implementation" section.

••••Introduction••••

Universal cabling systems are complex, and yet, if properly designed, are easy to use and administer. They can be fashioned uniquely by the user, or, if you prefer, can be purchased in modular, prepackaged systems from a growing list of vendors.

The primary attraction to universal cabling systems, of course, is that they allow users to wire once for the long term. This is a welcome change compared to the seemingly endless stream of retrofits and rewiring that most schools encounter in the normal course of business.

Universal cabling systems are effective mostly because of their system - and/or vendor-independence. They minimize, if not totally eliminate, the need to rewire the facility with every new wave of equipment that users experience over time. As previously discussed, this is a radical departure from past procedures.

••••Key Features••••

In order to properly function in this *universal* manner, a cabling system must exhibit the following key features. The wires or cables must be recognized by the industry as *standard* by the relevant standards-setting bodies such as the Telecommunications Industries Association and the Electronics Industry Association (TIA/EIA), and by the community of mainstream voice and data system vendors. (*See Table 1.*)

The connectors and other terminating hardware also must be standard, as recognized by the relevant standards-setting bodies and the vendor community at large.

••••Structure••••

Universal cabling systems are structured into hierarchical segments, again according to the orders of the relevant standards-setting bodies. The key segments of these structured cabling systems are the horizontal and the vertical segments. The structured nature of universal cabling systems enable users to engage only those segments required for a specific mix of applications at any given time. When the mix changes, certain segments are disconnected in favor of new arrangements to suit the new equipment. A well designed universal cabling system will be sufficiently modular in its physical design to enable a cable used for a telephone on one day to be reassigned to a LAN on the next day simply by having the user unplug the far end and move it to the new LAN segment.

Modularity in a universal cabling system is the result of two very important features. First the connections or terminating hardware at each end of each segment must be easy to use. Reassigning cross-connections should be as simple as literally unplugging from one jack and reinserting them into

another. Second, all individual plugs, jacks and other connecting media must be clearly *labeled* with a single digit MAU number, single digit port number, and three digit room number for ongoing use and more importantly, for reuse in supporting new applications over time. This should be possible to do by hand without any specific tools or techniques.

Table 1

Standards-Setting Bodies

The five relevant organizations and their respective standards are:

1. The Telecommunications Industries Association and the Electronics Industries Association (TIA/EIA)

   Relevant Standards: Commercial Building Wiring Standard, SP 1907

2. The American National Standards Institute (ANSI)

   Relevant Standards: Fiber Distributed Data Interface (FDDI), Incomplete as of May, 1990
   National Electric Safety Code

3. The Building Industry Consulting Services, International organization (BICSI)

   Relevant Standards: Telecommunications Distribution Methods Manual

4. The Institute of Electrical and Electronics Engineers (IEEE)

   Relevant Standards: 802 Committee Standards on Local Area Network Topologies

5. The National Fire Protection Association (NFPA)

   Relevant Standards: The National Electrical Code

••••Cabling Design Phases••••

It is useful to think of universal cabling design and implementation in three stages: the design phase, the installation phase, and the application or cable management phase. The design and installation phases take place before the renovated or new facility is occupied. The application phase refers to the actual use of the system both initially as well as on an ongoing basis. Users contemplating universal cabling should recognize the three phases of development noted above and be absolutely certain that corresponding documentation of actions taken is properly produced at each phase. (*See Table 2.*)

Table 2

Phases of Cabling Design and Implementation

	Phase	Relevant Documentation
1.	Design Phase	Graphical Design Drawing • System Schematics • Riser Diagrams • Wiring Closet Drawings • Equipment Room Layouts • Cabling Floor Plans Narrative Technical Specifications Cabling RFP
2.	Installation Phase	As-Built Documentation by the Installer Updated Design Documentation by the User
3.	Application Phase	Cable Management System • Inventory • Location Data • Resource Allocations • Application On-Line • Users

Users involved in major facility changes (moves, expansions or renovations) generally find themselves working with architects and engineers who together are responsible for producing formal construction documents. Construction documentation generally takes the form of drawings and written bid specifications.

Installation phase documentation should be used to update design documentation in preparation for the application phase. Installation phase documents reflect labeling schemes used by the installer; and, therefore, serve as an early road map to use in determining where components are located.

Application phase documentation forms the nucleus of the cable management system which is largely based on the content of the design and installation data. A well defined cable management system will associate people, systems, and specific equipment with the cabling system so that day-to-day administrative tasks such as moves, adds, changes and problem diagnosis can be properly supported.

••••Cable Management••••

The use and reassignment of wires and cables in a universal cabling system must be supported by good documentation. Even the smallest of these systems will consist of literally hundreds of discrete wire segments, outlets, patch panels, and other components that can be arranged in endless ways. Knowing at any time exactly how the system is presently configured is critical. A sound cable management system is essential in doing so. A well constructed cable management system will support the following important functions: troubleshooting, preventive maintenance, system implementations and asset management. When problems occur that suggest that the wiring media is the culprit, documentation regarding the entire circuit involved is fundamental to the analysis that follows. A well designed cable management system will enable the technician to trace specific circuits end-to-end, including all intermediate terminations, cross-connections and the specific paths involved. Moreover, the same documentation will identify alternative circuits that can be used to bypass the troubled area. This application has obvious implications in the context of disaster recovery plans.

Proper documentation at all three stages of a cabling system design and implementation is critical. School officials who recognize this and who respond accordingly can look forward to a long term payback on their investment in universal cabling.

MATCHING INSTRUCTIONAL/ADMINISTRATIVE ACTIVITIES WITH TELECOMMUNICATIONS STRUCTURE

Now that the planning process has been outlined and cabling discussed as a key component in the renovation or construction process, this section looks at the array of applications which this cabling structure can support.

••••Generic Examples: Telecommunications••••

LOCAL AREA NETWORK (LAN)

What is a Local Area Network?

Local area networks fall into basic categories:

- broadband networks
- baseband networks.

Broadband LANs - Local area networks that fall into the broadband category are usually the exception, not the rule. Broadband networks differ from their baseband counterparts in that they use coaxial cable or fiber-optic cable to carry multiple channels of data. With broadband, one cable can be used to carry five or six different communication channels, and each channel is distinctly separate from the others. In some ways, a broadband network is analogous to cable TV. Only one cable connects the house to the cable television service, yet this one cable carries multiple channels.

Broadband networks use analog transmission methods, which allows the cable to handle information at different frequency levels. Each frequency level forms a separate, autonomous communication channel. Frequency levels are basically determined by how many cycles occur each second. Thus, a frequency level between 100 Hz (hertz or cycles per second) and 300 Hz comprises one channel. The frequency between 400 Hz and 700 Hz comprises another channel. The number of channels a cable can accommodate depends on how many cycles per second the cable can handle. The higher the frequency limit, the more channels of data are permitted.

A broadband network is ideal for an environment like a university or hospital. The broadband network provides data transmission, audio transmission, and video transmission all on one cable. This one cable is basically all that would be needed to network the entire campus or facility.

Baseband LANs - The majority of local area networks are baseband LANs. A baseband network uses only one channel on the cable to support digital transmission, which is much faster than analog transmission.

The LAN Defined - The generally accepted definition of a LAN is two or more microcomputers connected that communicate with one another through some physical media, such as twisted-pair or coaxial cable. These microcomputers share data and peripheral devices and usually have transfer speeds of at least 1 Mbps (millions of bits per second). The microcomputers are usually located in the same limited geographic area, such as one floor of a building.

This is admittedly a simplified definition of a LAN, but it will serve as a basis for understanding local area networks.

The Features of a Local Area Network

LANs offer many benefits to end users. Many of these features, such as sharing data and printers, are similar to those offered by minicomputers and mainframes, but with the added benefit of significantly reduced costs. Listed below are some of the advantages a local area network can provide:

- Shared Data
- Shared Hardware
- Better Use of Existing Hardware
- Electronic Mail
- High-Speed Data Communications
- Distributed Processing
- Metered Software Applications

Local Area Networks And Data Communications

LANs are an entirely separate category within data communications and networking. For example, one distinct difference between a mainframe system and a LAN is that in the mainframe all processing of files and communications is centralized, and is handled by the host. With LANs, processing power is distributed among the workstations and file servers.

Today, LANs are creating quite an uproar in large and small corporations. With new software and hardware, the power of the LAN has increased immensely (although many still refuse to acknowledge this). The trend toward downsizing - making the MIS department smaller and more responsive to the end users - lends itself extremely well to the LAN. Departments want to control their own data, and with a LAN they can do just that.

LAN Components

The components required to operate a LAN can be divided into two major categories:

- Hardware
- Software

The hardware components needed for a local area network consist of the following five items:

- File server
- Workstation, computer or terminal
- Cabling
- Network Interface Cards (NIC)
- Hub, concentrator, or wiring center (optional)

The software necessary to operate a local area network consists of the following three items:

- Network operating system
- The operating system for the workstation
- The workstation network shell, or the requestor or redirector

CHARACTERISTICS OF LANS

SPECIFICATION	TOKEN RING	ETHERNET	APPLETALK WITH LOCAL TALK
Logical Topology	Single Ring	Bus	Bus
Physical Topology	Ring, Star	Star, Bus, Hierarchical	Bus, Star, Ring
Transmission Technique	Baseband	Baseband	Baseband
Media	Twisted Pair, Optical Fiber	Twisted Pair, Coaxial Cable, Optical Fiber, Microwave	STP, UTP, Optical Fiber
Bandwidth	4 or 16 Mb/s	10 Mb/s	230.4 kb/s
Media Access	Token Passing	Carrier Sense Multiple Access/Collision Detection	Carrier Sense Multiple Access/Collision Avoidance
Token Acquisition	By setting status bit, converts token into a frame.	Not Applicable	Not Applicable
Token Release	After receive (4) After transmit (16)	Not Applicable	Not Applicable
Messages on LAN	Single (4 Mb/s rings) Multiple (16 Mb/s rings)	Single	Single
Maximum Frame Size	4,500 bytes (4) 18,000 bytes (16)	1,518 bytes	603 bytes
Encoding	Differential Manchester- 50% efficient	Manchester 50% efficient	FMO (bi-phase) space
Number of Nodes	260; 72 with UTP	1024	32/System; 254/Network
Distance between Nodes	100 - 300 m	2.8 km	1000 Feet
Max Network Span	Varies with Configuration	2.8 km	≈4500 Feet
End User Devices Supported	Mainframes, Minicomputers, IBM PC & Compatibles, IBM PS/2 Series, Printers, 3270 Terminals	IBM PCs and Compatible, IBM PS/2 Series, Apples, Macintosh, Printers, Terminals	Minicomputer, IBM PC's and Compatible IBM PS/2 Series, Apples, Macintosh, Printers, Terminals
High Level Protocols	TCP/IP, SNA (depends on vendor)	TCP/IP, Appletalk (depends on vendor)	Appletalk
Vendor Supplied Software	Network Operating System (OS); Utility Software Application Software (IBM)	Network (OS); TCP/IP Communications Protocol (Racal, Interlan, Inc.)	Network Operating System
Other Software	Novell Netware (others may depend on vendor)	Novell Netware (others may depend on vendor)	Novell Software IBM PC LAN Program (others may depend on vendor)

SUMMARY OF FEATURES
NETWARE 2.2 AND NETWARE 3.11

	NETWARE 2.2	NETWARE 3.11
GENERAL INFORMATION:		
Maximum number of users	100	250
Other user configurations available	5, 10, 50	20, 100
Processor required in server	80286	80386 or better
Dedicated server required	N	Y
SERVER CONFIGURATION:		
Required FAM	500K	1MB
Recommended RAM	2.5MB	6MB
Disk Caching allowed	Y	Y
WORKSTATION CONFIGURATION:		
Required RAM	70K	70K
Recommended RAM	640K	640K
FILE SYSTEM:		
Concurrent open files per server	1,000	100,000
Volumes per server	16	Unlimited
Physical drives per volume	1	32
Physical drives per server	32	2,048
Maximum file size	256MB	4GB
Maximum volume size	255MB	32TB
Maximum physical RAM	12MB	4GB
Maximum disk storage	3GB	32TB
PROTOCOLS SUPPORTED:		
AFP (Apple Filing Protocal)	Y	Y
IPX/SPX	Y	Y
NetBIOS	Y	Y
OSI	N	Y
TCP/IP	N	Y
FILE SYSTEMS SUPPORTED:		
Macintosh	Y	Y
NFS	N	Y
OS/2 HPFS	Y	Y

Major differences:

- Netware 3.11 allows enhanced ability to run special programs in the server as part of its multi-threaded processing capability.
- Netware 3.11 allows multiple-protocol connectivity to all types of computers (although some connectivity features require purchase of add-on software).

Source Cited: Thompson, M. Keith. "NETWARE 3.11 Revising the Standard". PC MAGAZINE, October 15, 1991.

MEDIA AUTOMATION

Overview:

When discussions of automating the school library media center begin, one of the topics should be how to use a school telecommunications system to support the automation of the media collection. As of June 1991, over 1500 of the North Carolina schools reported media automation for circulation or an online catalog. Approximately half of these locations were involved in some stage of implementing a local area network for the online catalog with user stations within the school library media center. Of this number, approximately five were involved in placing user stations in classrooms. The number of these online catalog users exploring the possibility of placing user stations throughout the school is increasing each year. To accomplish this distribution of online catalog access outside the school library media center, planners need to consider a school telecommunications wiring plan.

Connections:

Even though most media automation networks currently consist of a few networked micros, all located within the media facility, media coordinators and school administrators need to plan for possible expansion of the network to include one or more of the following:

- connection to the school administrative computer to transfer student personal data. This is being done now by diskette transfer either by the user or by the media automation software company. Transferring the data from the administrative system eliminates rekeying of information about each student into the media computer and allows transfer of data on media fines and other obligations from the media computer to the administrative system. Replacing diskette transfer with network data transfer would save time and ensure better data integrity.

- connection to the classrooms enabling students and teachers in the classroom to search the online catalog or databases available on the same host or a peripheral CD-ROM drive in the school library media center.

- connection with other school networks enabling students to use those networks to search the school library media center host for information and incorporate into their assignment on the instructional network.

Implementation Stages:

<u>Stage 1: Within the School Library Media Center</u>

To "automate" the school library media center collection, the media coordinator undertakes to provide by use of microcomputers and special software access to the books in the school library media center. Periodicals and other print/nonprint materials are added often at a later stage or as time and money allow. For many school library media centers the first step is to purchase a computer with a barcode pen and a printer and a software program for circulation of items. In this stand-alone machine scenario, the students check out books by scanning with the barcode pen the barcode which is placed on each book. The circulation software on the "circulation station micro" records the transaction and updates various records for later use for overdues, circulation tracking, and collection development.

A second scenario involves the purchase of several microcomputers and networking software, cables, and interface cards in order to implement not only the circulation of materials but also the online catalog search activity. In these setups, the students can use a "search station micro" to access the record of a particular item or to scan for a group of items instead of searching the paper cards in the card catalog. This search station is networked by cables to a host microcomputer on which the full record for the collection items reside. The "circulation station micro" is attached also by network cables to this same host.

The total minimum media automation network for use in the school library media center consists of 3 microcomputers, 2 printers, and 1 barcode pen: 1 host/server with printer, 1 circulation station with barcode pen, 1 user/search station with printer. Depending on the automation software used, the maximum number of "search stations" will vary. A desired network would include 1 host micro, 1 circulation micro, and one user/search station micro for every 250 users, with printers for each user station and the host.

A third scenario is the addition of a CD-ROM drive to the online catalog local area network. This addition requires special CD-ROM network software (e.g., CBIS, Optinet, SCSI Express) in addition to the local area network software (e.g., Novell Netware) already installed.

Stage 2: To Other Locations

A. Administrative Unit

Several options exist for connecting the school library media center network system to the administrative office system: (1) bridging compatible but separate networks, (2) placing both system hosts and user stations on the same network, and (3) using a common host computer for both systems with user stations on a common network. In any of these options, planning for implementation should be part of a school telecommunications network.

B. Classrooms

A second stage in adding additional user stations to those in the school library media center is to place user stations in each classroom. These user stations would consist of a microcomputer similar to those in the school library media center, with a printer added as funds allow. To accomplish this extension of the network, the classroom user stations should be part of a school telecommunications network. This connection will improve data access time and allow easier relocation of classroom units. Connecting the classroom user stations to a combination outlet in the classroom wall and adjusting the connections in the nearest wiring closet is a much easier and safer connection than stringing cabling across the ceiling from the library, down the hall, and into the classroom.

Stage 3: Instructional Networks

A third stage in providing access to the school library media collection by telecommunications is to connect the media center's network with other school networks, using special software and network connections. The use of a school telecommunications network will allow these connections to be made with minimal effort and increased assurance of data transfer. However, utilization of the data from another system will require special software or software modifications. Simply connecting the hardware does not ensure that the applications on the different networks can exchange the data in a usable format.

TEACHER STATIONS

Overview:

As various types of technology are becoming more commonplace in the school setting, the classroom teacher is faced with a growing need to have ready access to computer databases for both management and instructional purposes; to develop and deliver lessons using interactive technology; and to open the classroom walls to the world in search of new information and connections to others. Yet, in most North Carolina schools, inadequate funding and a lack of vision have limited the access of the teacher to the necessary technology. Teachers either use a centrally-located staff computer, a student station in a lab or school library media center, or an "older" micro placed at the back of the classroom, or have access to no computers at all. As new facilities are being built and renovations are being made to existing buildings, educators need to consider providing a sophisticated micro-based teacher station in every classroom and connecting it to the school-wide telecommunications network.

Connections:

Three different, but very important, activities become more effective and efficient when a classroom teacher station is connected to the school telecommunications network. For example:

- During the course of any work day, a teacher receives or sends a variety of information to the principal's office: student attendance, field trip lists, class time changes, and school events. These data are transferred from the office to the classroom or vice versa by paper or by a voice intercom system. Even though attendance records are computerized in the principal's office for most North Carolina schools, the teacher still maintains a paper system within the classroom.

- Teachers are using a variety of equipment to develop and present their lessons; however, a majority of the equipment does not offer interactive features. Thus, once the lesson material is developed or selected, it is presented only in the sequence or format of its original development. There is no opportunity to explore "what if" questions or to proceed with the lesson in the direction of questions from the students or to interact with students in other locations focusing on that same issue.

- As teachers search for additional resources and information to incorporate into their lessons that will prepare students for the twenty-first century, they are beginning to use multi-media materials. For instance, they may use videodiscs, which have full motion video sequences and full color still prints, and access online databases or electronic mail systems for current information. In most cases there is limited technology in the school for these activities. For example, as educators have begun using videodiscs, the school has purchased one videodisc player to connect to a mobile computer system or has placed the unit in a lab or an area of the school library media center for group use. Likewise, as teachers have requested access to online databases such as Dow Jones News Retrieval to acquire timely information for economics projects, schools have installed a phone line or a cut-off switch on an existing line—often in the school library media center. Thus, the teacher has to move the class to that location or "string" a long stretch of phone cabling to the classroom.

Implementation Stages:

Stage 1: Within the Classroom

The first teacher station in a classroom is typically a stand-alone computer with some form of large group display device. The display may be a 25"-27" monitor or a liquid crystal display (LCD) palette placed on an overhead projector. In this scenario, the teacher may use the teacher station for software demonstrations or lesson enhancements. Most microcomputers in this situation are older units with specific software for which the teacher has ready access. A second step for classroom use is the specialized mobile unit. In this case a stand-alone unit is placed on a cart, with a peripheral such as a VCR or a videodisc player or a CD-ROM drive. This mobile unit then becomes the multi-media station that the teacher reserves to present a lesson or demonstration. Neither of these examples of a teacher station within the classroom is part of a school telecommunications network. However, both have the potential to become part of the school-wide network with the addition of network cards, cabling, and additional memory.

State 2: Beyond the Classroom

Administrative Connection: One of the first applications of connecting the classroom teacher station to a location outside of the classroom is an administrative one. With the existence of the Student Information Management System (SIMS) in most North Carolina schools, examples already exist of connecting classroom stations to the SIMS network. However, the first application is usually electronic mail, rather than a SIMS function. The school principal can use an electronic mail software package on the network to send messages, request information, and publish the daily announcements. Some schools are trying a second step: teachers keying their students' grades into a grade reporting program on the network. This action replaces the diskette transfer necessary now from miscellaneous stations containing the grade reporting software to the SIMS station or network. In both of these instances, the use of a school telecommunications network would facilitate the data transfer and allow easier expansion both to other classrooms and to other applications. A third administrative application which should be considered in planning for a school telecommunications network would be an extension of some of the electronic homework hotlines currently being used. Teachers could use their classroom teacher station to type absentees and homework assignments into the school network, rather than waiting their turn to use the one specially-configured homework hotline station.

Multi-Media Connection: One of the first instructional, interactive uses of a teacher station is to "deliver" the lesson or to conduct a group activity. Often the teacher connects a videodisc player to the teacher station. Using a barcode pen or a computer program the teacher accesses random segments on the videodisc to present a concept with a combination of full motion video, still images, and audio. This visual and audio experience provides new dimensions to the lesson. A second step is for the teacher to use scripting or authoring language on the teacher station to access the multi-media images via "hot spots" as the lesson progresses or as students ask questions. Both of these scenarios succeed in a stand-alone or mobile cart environment. Yet, with a connection of the classroom teacher station to the school telecommunications network, the videodisc could be in the school library media center, accessible to more people rather than available to only one class.

Information Accessing Connection: A second instructional application connecting the classroom teacher station to another location is accessing information. Many North Carolina schools are experimenting with a variety of information accessing arrangements: the classroom teacher station

connected to telephone lines in the classroom wall for online database access, the classroom teacher station networked to the online catalog or CD-ROM drive in the school library media center, or the classroom teacher station connected as a station on an instructional network in the school.

This involves connecting the classroom teacher station to a host/server computer containing the application software. In almost all of these instances, only one of these applications is being tested at one time. However, a school telecommunications network would provide the optimum route for data connections and flexibility for multiple applications to be available simultaneously.

STUDENT STATIONS

Overview:

As reports are made by various commissions studying skills needed by students in the twenty-first century, educators continue to be told that each student needs basic skills. Often, however, a new basic skill is mentioned: computer skills or information accessing skills. Indeed, to succeed in the technology-rich, information-filled society which is fast developing, students need to be comfortable using computers and other technologies.

Connections:

Students should have the opportunities not only to strengthen their knowledge of basic content, but also to develop problem solving, information accessing, and communication skills. Thus, school leaders and planners will face the need for a multitude of student stations throughout the school facility. With a school telecommunications network, the use, expansion, and support for these individual student stations will be implemented and managed. Possible student station benefits with a school telecommunications network would be:

- In a computer lab with stand-alone microcomputers, the teacher, media coordinator, or students must load the software into each machine to be used. This involves locating the software, loading it into the machine, and returning the package to the proper location after use. Daily handling of this type decreases the student work time and increases the possibility of damage to or loss of the diskette. With these microcomputers networked to a host computer within the room, the students have more work time and the diskette handling issue is resolved. However, the software now resides on the host in the computer lab and is not available for use by students at computers in other locations of the building. With the computer lab units connected to a school telecommunications network, students could use the software and their work files from other locations in the building.

- In order to strengthen student math skills, educators have begun using computer programs for students to practice the skills they need and for teachers to track the student progress. Often school leaders purchase a complete, networked computer lab for these special applications. If a school telecommunications network exists, this special application network can be connected in order for student progress reports to be transferred to student information files in the administrative office and for students to access the lessons from stations throughout the school.

Implementation Stages:

Stage 1: Within One Location

Historically, a student station in North Carolina schools has been either a stand-alone microcomputer with one disk drive in a general-purpose computer lab or a similar unit placed in a classroom. In both instances, printers were added as monies allowed. Students are using a wide variety of software, typically basic skill software and word processing software. A second step has been to network the units in the computer lab in order to better manage the software and to implement student performance management software.

For most cases, the microcomputers in the classroom and those in a lab—networked or stand-alone—could become part of a school telecommmunications network but they would need networking cards and cables, and possibly additional memory. Some of the older microcomputers might be better used as stand-alones for special applications than spending money to "improve" them to communicate on the school network. However, if the investment would be cost effective, then the connection of the stand-alone student stations in the classroom and in the computer lab to a school network would allow access to the same software throughout the school, would provide availability of student performance tracking information at different stations, and would eliminate possible occurrences of copyright violations.

Stage 2: Distributed/Multiple Locations

A second stage in providing easy access to student stations is to form a distributed student station network with a host microcomputer in one location networked to student stations in the classroom. In this scenario, educators often distribute the stand-alone stations in an existing lab to classroom locations or purchase additional units to place in the classrooms. They purchase a more powerful microcomputer to be the host computer and they invest in network cards and cabling. This distributed network provides common software programs to each classroom and allows file transfer of student work. However, the halls become areas with cabling looped from beam to beam and the classrooms have cabling flowing from the transom to be taped down the wall and across the floor molding to the computer area. As other classrooms are added to this network, the cabling becomes a more confused mass of wires, almost impossible to manage or to follow in order to trace a transmission problem. With a school telecommunications network, the classroom activity of a distributed network would remain the same but the consistent delivery of programs would be more assured and the appearance and safety conditions of the facility would improve.

ADMINISTRATIVE STATIONS

Overview:

In the North Carolina schools, the use of microcomputers for administrative applications is a common practice. At least one microcomputer system is available in the administrative offices for student information. Many schools have extended this beginning use in several ways: other microcomputers networked to the host unit for student information; unit or units for grade reporting; unit with a scanner for test scoring; unit for an electronic homework hotline. Several schools are connecting classroom or lab computers to the administrative network to facilitate reporting of grades while a few are experimenting with placing their media automation software on the same host as the

administrative software. This latter activity has been undertaken to save purchase of a second host computer and to more easily transfer student information between the two applications. In only a very few schools—in some of the newest facilities—have educators implemented a school-wide administrative network. In these cases, the full potential administrative use is still several years away.

Connections:

With a school telecommunications network the possible administrative applications are numerous. In fact, such a network could restructure the existing way of "doing business" in a school of today. For example:

- Many advances in automating attendance reporting have already occurred. However, if a teacher could key or scan the student identification numbers of those absent from a given class into the networked classroom teacher station, attendance reporting would be transferred on the spot.

- The school intercom system or public address system has been viewed by many teachers as a necessary nuisance. If the administrative staff could "send" the message to the classroom either via electronic mail (data) to the classroom teacher station or via video messaging to the classroom monitor, then the classroom activity is not interrupted. The existence of a school telecommunications network would provide the "path" to send these messages to every location simultaneously.

- As candy sales progress, recordkeeping becomes a major job for the classroom teacher. Using paper charts and daily reporting forms, the teacher spends considerable time maintaining the records. If the teacher or a student could key into the classroom teacher station the amounts received as the money is collected and then transmit this record to the bookkeeping office on a daily basis, the teacher spends less class time and improves the chance for correct recordkeeping.

Implementation Stages:

<u>Stage 1: Within the Office Complex</u>

The first expansion of computer use in the administrative office area is usually to provide a second station for an assistant principal or SIMS operator or the SIMS activity. Other micros are added for other administrators, the attendance counselor/secretary, and the guidance staff. Usually a scanner and a high-speed heavy-duty printer are peripherals added to the office complex. A second step is to network these units within the office area, using a unit with a large hard disk drive and a fast processor. This network provides up-to-the minute records for all users and allows maximum use of fewer peripherals such as the high speed printer.

Sometimes a different second step is to add additional applications such as a homework hotline for calling student homes concerning attendance and providing an announcement bulletin board for the community to call. Or a second stop might be a grade reporting application station to which teachers bring their data diskettes of student grades to be moved into a school file.

Stage 2: To Other Locations

Once an office complex network is in place, the next stage for administrative application expansion is to place administrative stations in other locations. Stand-alone units can suffice to offer the staff opportunities to input grades, check student performance progress, and record homework assignments. However, if these administrative units are connected to a school telecommunications network the data can be input directly rather than be transferred by diskette. These particular units would be similar to the teacher stations but would be more powerful processors for faster online interactive and greater numerical calculations. Also, they would include voice capability for recording homework assignments.

TELECOMPUTING STATIONS

Overview:

Since the mid-1980's North Carolina schools have been "reaching out to touch someone" via telecomputing. Using a computer, modem, telephone line, word processing package, and communications software, students have exchanged letters and participated in collaborative projects with students in other North Carolina locations, in other states, and in countries such as Australia, Japan, and England. These activities have increased student knowledge of geography, world events, universal student interest, and multicultural differences. Students have gained computer skills of general computer use, of word processing, and of telecomputing. They have also learned to work cooperatively. Yet, perhaps the greatest outcome has been improvement of writing skills. Teachers report that student writing skills improve when they are writing for a distant, peer audience. Teachers have used telecomputing to enrich their lessons with current information and to provide students an opportunity to go beyond the four walls of the school.

Connections:

Telecomputing is currently a stand-alone activity in the North Carolina schools. However, with the existence of a school telecommunications network, students, teachers, and other staff members could have access to the world from any location in the school facility. Several possible connections would be:

- As a seventh grade social studies class is discussing current events in Africa, they could "dial up" the Dow Jones News Service or check the X-Press X-Change latest transmission. On the monitor of the computer station in their classroom they would have the latest information available. This would be possible from any of the seventh grade classrooms or any other location with a dedicated telecomputing computer and modem connected to the school telecommunications network. Otherwise, each classroom would need access to a mobile telecomputing station and a separate phone line.

- A sixth grade class is working with a peer class in Australia on travel brochures for kids visiting their locality. Part of the class is investigating resources in the school library media center and the remainder of the class is preparing the brochure in the computer lab down the hall. Each group has been assigned to compile a list of questions that need to be answered by the kids in Australia before they can finish their research and draft the brochure. With a school telecommunications network, each group uses the telecomputing station in their

location to send the file with the list of questions to their school system FrEdMail system for overnight transfer to Australia. Thus, they are able to continue work rather than relocating to the one telecomputing station in the school.

- An economics teacher is working with the media coordinator to prepare a unit on the stock market. As they investigate materials in the school library media center, the media coordinator demonstrates the various online databases that the students could search. Once the teacher returns to his classroom, he uses his teacher station connected to the school telecommunications network to connect to one of these databases to gather more ideas for the design of the unit. He also tests how he could use the classroom station as a teaching station by connecting to the online database during the lesson.

Implementation Stages:

Stage 1: One School Telecomputing Station

The first occurrence of telecomputing in a school is when an individual becomes excited about the possibilities, having read an article, heard a presentation at a conference, or witnessed an activity at a neighboring school. Once the staff member begins investigating telecomputing, the first obstacle to arise is usually not the availability of equipment but access to a phone line. Many times a computer and word processing software can be re-assigned for telecomputing and sufficient funds can be obtained to purchase a modem and communications software. Even money for the subscription or online charges to the database service or bulletin board is "found." However, the installation of a separate phone line or a new, dedicated phone line involves an initial installation cost and recurring monthly charges. These monies are often not in the existing school budget. This funding issue is often coupled with apprehension about the control of the use of the line for appropriate calls. With sufficient data and plans for appropriate access, many schools have overcome all of these barriers in order to benefit from telecomputing.

The first telecomputing station is usually an older microcomputer system placed in the school library media center. This system includes a printer, modem, word processing software, and communication software. It is typically on a cart to be rolled from a secured place into the main use or reference area for easier use by small groups or classes. By use of a long telephone cable, the mobile unit can be connected to the phone in the school library media center. However, the next step, once use of the system really begins, is to install a separate line to the usable location in the main use or reference area and place the mobile unit there. If the unit remains on a mobile cart, then it can be used in another location in the building where there is access to a phone line.

Stage 2: Multiple School Telecomputing Stations

As interest in telecomputing grows and monies are available for additional units and phone lines, many schools are adding telecomputing units in order to have permanent access in the school library media center reference area, in the general computer lab, and in the vocational education wing (e.g., for business classes, for health occupations). With a school telecommunications network, these classes could share use of the equipment and the telephone lines rather than each having separate units. As the variety of telecomputing use and the number of users increase, educators will need to consider a "better" way to provide telecomputing stations than to continue to add a system and another phone line each time a request is made. A school telecommunications network is one

solution. Educators need to consider such a network as they develop long-range plans which include telecomputing opportunities for students and teachers.

••••Generic Examples: Television••••

TELEVISION SYSTEM: SIGNAL SOURCE/RECEPTION

There are three major components to a television system — reception, processing, and distribution. Reception is the most important element of any television system. If the received picture is poor (TASO 4 or 5), there is nothing that can be done to make it better. Therefore, the first objective for quality television is to capture as much good quality signal as possible. (*See "Appendices" for complete description of TASO scale.*)

Antenna:

Most North Carolina schools receive only one channel from the University of North Carolina Center for Public Television (UNCCPTV) network. (*See "Appendices" for channel designations for individual localities.*) Therefore, particular attention must be paid to the reception and processing of that channel.

First of all, there must be a television signal to receive. Further, the signal needs to be strong and clean in order to provide a good quality picture (TASO 1 or 2). A school site survey should always be made to determine the field strength of the desired channels. Along with the desired channels, undesired channels and potential sources of interference should be checked. These data are used in selecting the antenna, its support structure and its location.

Antenna selection is critical to the rest of a television system. Its prime function is to collect as much signal as possible. It can be a simple yagi-type designed for optimum performance on a single UHF or VHF channel. It can also be an array of yagi-types so arranged as to increase the amount of signal received and/or to decrease the amount of interference and ghosts received.

Antenna location is also of great importance. The antenna must be located in the signal path. Antennas should be about 30 feet above the ground and four to eight feet above the upper roof line. Antennas should be clear of natural and man-made obstructions. Antennas must have sufficient space between each other to prevent "inter-antenna" interference.

The antenna support structure must support the antenna through all types of weather. It must keep the antenna oriented in the desired direction. This structure can range from a complex tower to a simple mast bolted to a vertical wall. If a mast can be installed during construction, it can be welded to the roof truss which then allows it to serve as the cable access into the building.

A basic reception system for instructional or School Television (STV) consists of an antenna for the UNCCPTV signal and an outlet. Generally, there is a need to have a pre-amplifier ("booster"), the necessary power supply for this pre-amp, and the amount of coaxial cable necessary to carry the signal from the antenna to a wall outlet in the media center.

A pre-amplifier, or pre-amp, is the first active electronic component of a television system. It is usually mounted near the antenna on the support structure. A pre-amp is used when the received signal is too weak to traverse a coaxial cable to the headend and then be processed. The quality of the pre-amp, along with the strength of the received signal, will determine the quality of the television picture throughout the system. A pre-amp used with a very strong received signal can result in a badly distorted picture.

CATV:

Most of North Carolina is covered by one or more of the UNCCPTV transmitters or translators. Hence, most school sites will, using an outside antenna, receive a picture that is equal to or better than that received via cable. If, however, the site signal survey shows that little to no signal is available in the air, and a cable drop is possible, then cable can serve as a primary signal source.

Whether a school uses an outside antenna or not, it should take advantage of a free drop from the local cable facility, if such is available. Many cable companies are willing to provide this free drop provided the distribution cable is within a few feet of the school. Should a good deal of material and labor be involved, the cable company may charge for these and then provide free service. Local franchises may also specify the service a cable company is expected to provide to schools.

The drop should be to the media center at the location of the headend cabinet. From here, the signal can be processed.

Videotape:

Another method by which public schools can "receive" the STV programs is by acquiring videotapes of the various program offerings. These tapes may be obtained through a special duplication service offered through the Department of Public Instruction. Videotapes may also be obtained at the school by recording programs as they are broadcast. Videotapes, VCRs and video display devices are the "heart" of any on-going in-school television utilization program. Such equipment can be the sole source of STV programs for a school that receives no signal, either by antenna or by cable.

TELEVISION SYSTEM: SIGNAL PROCESSING

The second component of a television system is processing. Television signal processing is the electronic manipulation of the various inputs to the system. Processing is performed at the headend by amplifiers, filters, converters, processors, modulators and demodulators. The current state-of-the-art equipment has all but eliminated the use of amplifiers, filters, and converters. The new channel processors have built-in filters and amplifiers; and, they are frequency agile. Agility allows the processor to be tuned to any input frequency using a bank of DIP switches. The output frequency is selected in the same manner.

The basic purpose of the headend is to process desirable information and send it to the classrooms while undesirable information is blocked out or eliminated. A headend can easily be designed to handle 35 channels; however, it is important to try to use only channels 2 - 13. In so doing, any television receiver can be used with the system.

Some of the new integrated communication systems are using the television delivery system for material other than that related to classroom instruction. These intraschool communications usually use some of the channels between 2 and 6. There are technologies being developed which will encroach upon even more of the television spectrum.

Antenna:

The signals from any antenna are quite easy to process. The antenna downlead is connected directly to the input jack of the processor. The input DIP switches are set for the received channel; and, the output DIP switches are set for the channel you wish to distribute.

CATV:

Cable television in a school increases the need for system planning. There are a few pitfalls related to using cable television that must be kept in mind:

- First, cable companies may change the channel carrying the UNCCPTV signal. Many areas have periodically experienced a kind of "channel roulette". Use of frequency agile equipment rather than fixed channel equipment will circumvent any problems that might arise from such channel changing.

- Second, most cable systems carry a selection of "movie" channels, some of which are prohibited by law from entering public buildings. When this situation exists, the cable company typically scrambles or filters the channel prior to carriage into public facilities, including schools. However, sometimes the scrambling will not mask the audio.

- Third, several of the more popular cable channels, which may have some instructional use, are carried as part of a premium package. For the most part, premium packages require a set-top converter. Installing television sets classed "cable ready" will not always replace the set-top converter. (Educators should also be aware of and adhere to specific copyright restrictions that may apply to use of this programming in the classroom. Contact Cable in the Classroom for assistance, 703/845-1400.)

- Fourth, all cable companies will have programming on channels 2 - 13, if possible. If a cable company does not use one of these lower tier channels, the school system designer should also plan not to use the channel.

- Fifth, a channel elimination filter, which will remove one channel from a cable feed, does not always do a "clean" job. Furthermore, this filter is a fixed channel device. When "channel roulette" happens, the elmination filter may be removing the wrong channel.

To avoid the pitfalls, it is recommended that the desirable channels be identified. The NCPT channel should be processed off the cable in much the same manner as an antenna signal. Distribution of the NCPT signal can be on any standard VHF channel. The processor will provide the agility to follow the NCPT station to its new dial location if "channel roulette" happens.

The other desirable channels can be processed by any of three methods:

- First, additional processors can be used to pick off the channels. This method is used if the channel will be on the distribution system at all times.

- Another method is to use demodulators on selected channels. Demodulators are nothing more than tuners which strip away the carrier from RF signals leaving audio signals and video signals. These signals, in turn, are remodulated onto preselected channels for distribution. This method is used when any one of several channels may be on the system at any time.

- The third method is to use the tuner in a VCR to select a channel for distribution. The cable drop coming into the headend should have at least one tap which will permit access to the full cable service, less the scrambled and forbidden channels. This tap is then to be connected to the VCR, which, in turn, is used to demodulate whatever channel to which the tuner is set. This method is used to select a channel for distribution on special occasions.

Such processing of cable television signals serves two functions. First, sufficient channel space is provided for any type of CCTV or other intraschool communication use. Second, it eliminates the need for expensive, fixed channel elimination filters.

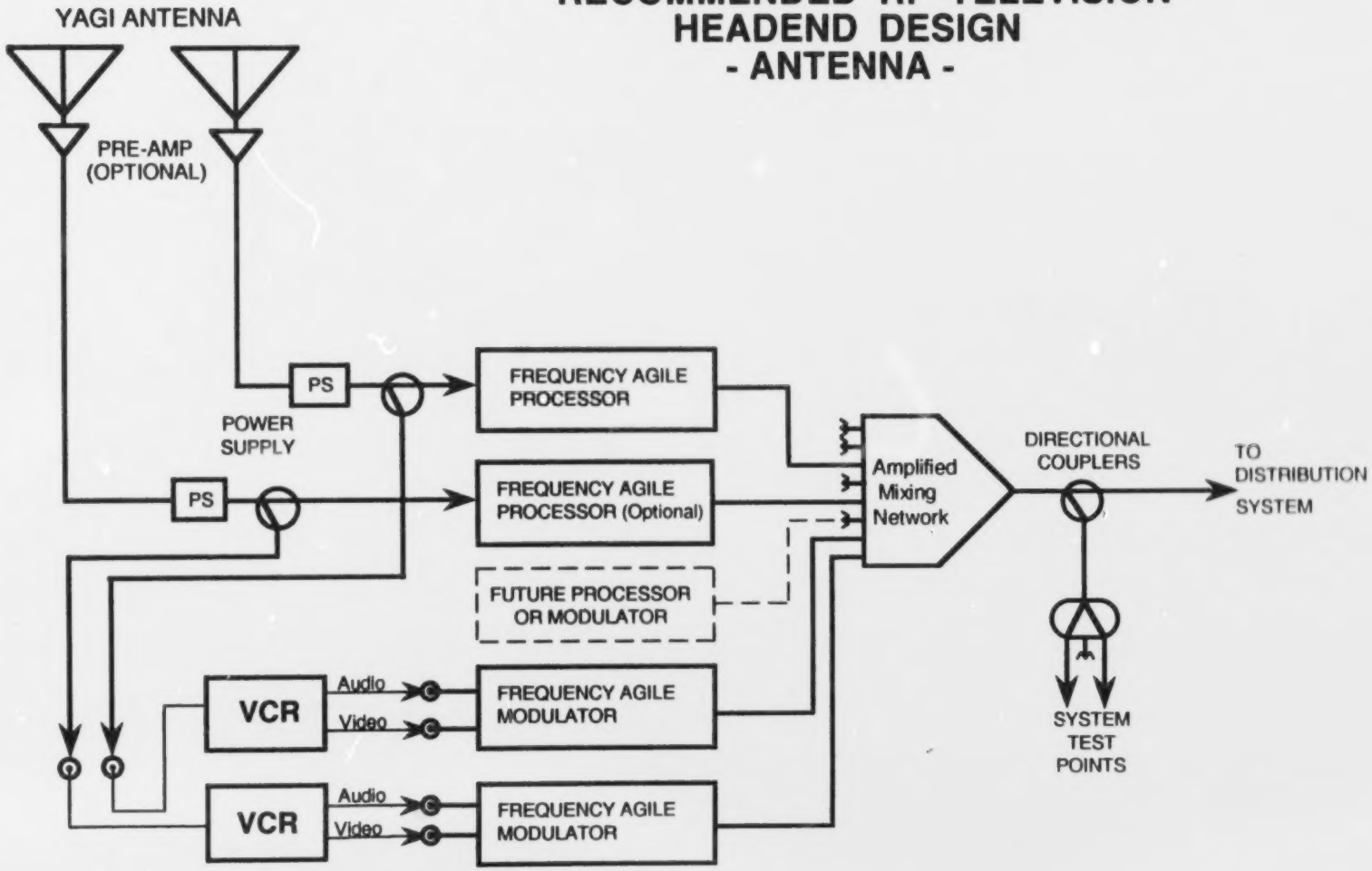
See the following drawings of headend design for either antenna or CATV signal reception on the next pages.

Video Playback Machines:

Also processed at the headend are the signals from video playback machines (including video-cassette recorders and videodisc players). The output signals are video and audio rather than RF. The RF output (may be marked as Ant. Out) of a VCR or disc player is for home use only and should never be used to feed a system because of poor picture quality.

Each video playback machine sends a set of signals - one audio and one video - to a single channel, frequency agile modulator. The modulator puts the signals on the RF carrier of a selected channel. A separate modulator is needed for each set of video/audio signals being processed onto the distribution system.

RECOMMENDED RF TELEVISION HEADEND DESIGN
- ANTENNA -



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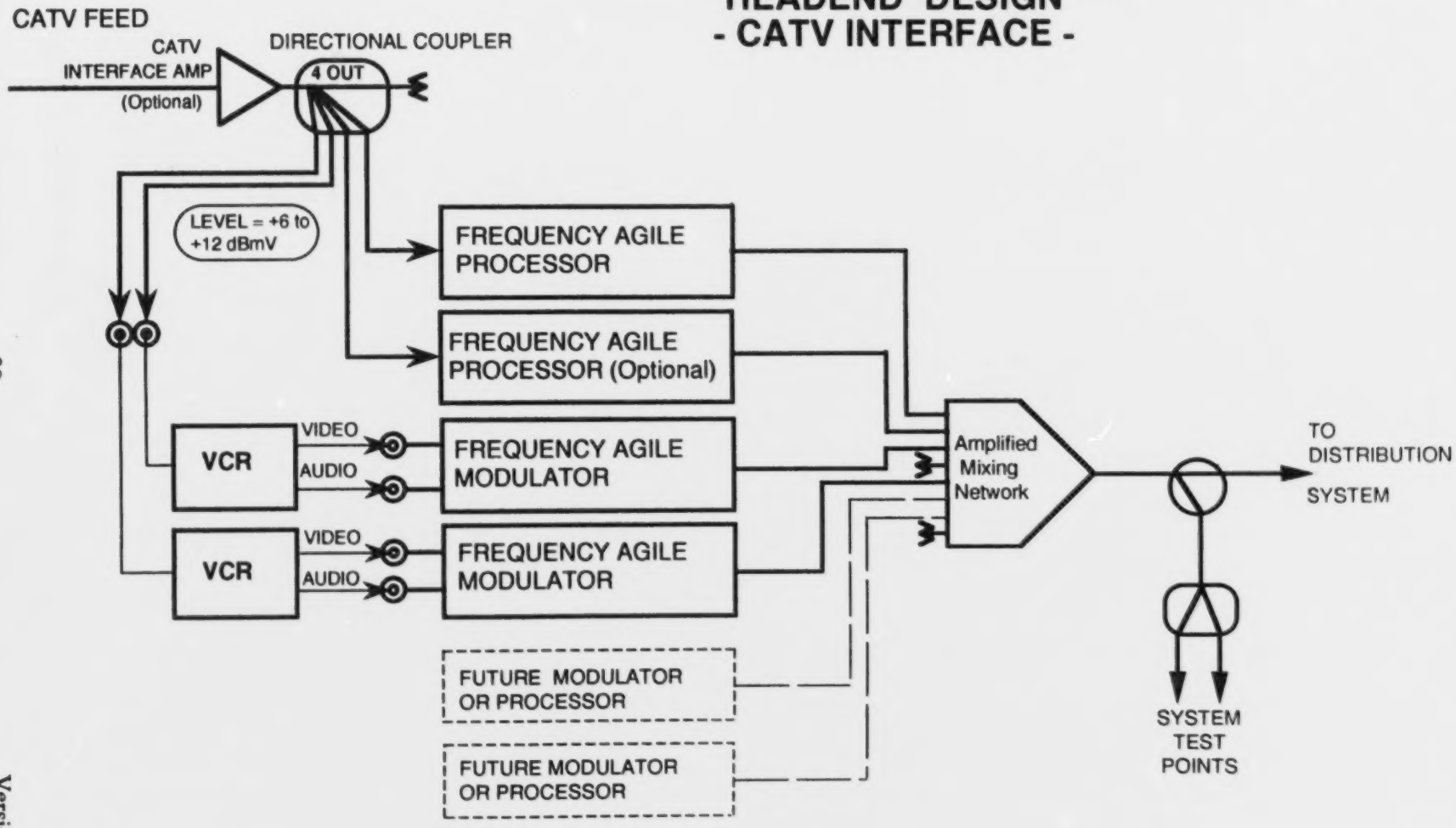
Dept. Public Instruction

RECOMMENDED RF TELEVISION HEADEND DESIGN
- CATV INTERFACE -



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Physical Support:

All television signal processing equipment and other active components, except the pre-amps, should be housed in a headend cabinet. The headend cabinet for a school's television system should be located in the media center workroom rather than in a mechanical or electrical room where there is a very real possibility of electrical interference getting into the picture.

With all of the new technologies coming on the market, there is a space relationship developing between communication equipment and television equipment. Much of this new communication equipment can be mounted in the same equipment rack as the television processors. The equipment rack should match the suggestions in 9.10 of the *Uniform Wiring Guidelines*. This rack should have four flat shelves which will hold four video playback machines. The processors and modulators will mount in the upper part of the rack along with the remote retrieval equipment.

To monitor the system, a 13-inch color television receiver should be mounted either on top of the rack, or someplace close by. The system operator can then check color balance, video depth, sound level and overall picture quality while standing at the rack. Nearby should be some sort of shelving to house the video tapes.

TELEVISION SYSTEM: SIGNAL DISTRIBUTION

The third component of a television system is signal distribution. Distribution is the sub-system that actually carries the television signals from the headend to all the various learning areas including classrooms, conference areas, media center, auditorium, principal's and assistant principal's offices, and maybe the commons, gym and/or cafeteria.

Picture quality must remain constant regardless of the number of sets in operation, or the distance between the set and the headend. A well designed, well calculated distribution system can and will deliver the same quality coming from the headend to all the television sets in the system.

The technology used to design a cable system for a community is the same technology used to design a school system layout. The only difference between the two is size and the fact that a school layout should never use remote or line powered amplifiers. System design is critical because of the amount of signal power that is lost in every foot of coaxial cable. Hence, all cable used in the system should be high quality, low-loss RG-6 type or larger. And, all cable runs should be splice free.

The various trunk and feeder lines of the distribution system fan out through the building or complex. The number of lines required and where they run is determined by the physical layout of the building(s).

The feeder line configuration would be that of a line-drop rather than a loop-thru. Thus, a feeder line would pass through a series of directional coupler tapoffs located above the ceiling. Each coupler tapoff, in turn, would have a single line-drop to a feedthru connector in the wall outlet. These couplers must be carefully selected so that each TV set receives an adequate signal for satisfactory operation; yet, not too much signal as to cause damage to the television tuner. The mismatch effect of the tapoffs on the line may be cumulative and, therefore, the number of tapoffs on any particular line should be limited to 12.

The classroom TV outlet should be mounted vertically on the front wall as defined by the chalkboard, and positioned between four and six feet above the floor. There should be AC power close by. The outlet itself should be mounted on a steel frame which is fastened to the wall box and then covered with a stainless steel cover plate.

Such an arrangement, where the isolation device is overhead and the wall outlet is a simple feedthru connector, protects the system from any foreign object that might get lodged in the outlet. A broken feedthru connector is easier to replace than a directional coupler. Also, if the wall outlet is broken, the signal on the feeder line will not be interrupted.

SCHOOL TELEVISION ACTIVITIES

Overview:

Instructional television offers many advantages as a classroom resource. It employs technology which is familiar and produces a high comfort level for both teachers and students. Minimal expertise and equipment are necessary for utilization. School Television is instructional television programming provided by the North Carolina Department of Public Instruction as a learning resource for K-12 students in North Carolina. Pre-produced programming selected from a national balloting process is evaluated by curriculum specialists and a School TV Advisory Committee at the Department of Public Instruction. Selected programming is purchased (broadcast/off air record and use rights) by DPI. Other instructional television offerings are produced by multi-state consortia which DPI divisions join for a fee. School Television programming also consists of live specials or locally produced cultural or educational programs.

Activity Description:

School television programming is broadcast daily during school hours by North Carolina Public TV. The broadcast signal is transmitted statewide for reception by all schools. Individual classrooms with televisions connected to a master antenna or cable access can tune in School Television programming via the local educational TV channel. Schools in North Carolina can access and view School Television programming directly off air with proper antenna or cable connections, or record the programming on 1/2" VHS videocassettes. Off-air record and use rights are negotiated (usually for a specified time period) with producers and distributors prior to inclusion in the School Television broadcast schedule. Taped programming can form the nucleus of or be used to expand school video-based libraries.

A class which is studying entrepreneurship, for example, may want to see exactly what is involved in starting one's own business. A School Television series may offer such a program, one which describes the steps involved in setting up a private business, and discusses advantages and disadvantages common to sole proprietorships. The teacher wishing to incorporate this program into a lesson would have two choices for access: the class could view directly off the air at the time of scheduled broadcast, or the teacher or school media coordinator could tape the program for the teacher to use at his or her discretion. School Television, when used effectively, enhances learning. Visual resources increase visual literacy. Critical viewing sharpens analytical thinking.

The teacher is the key to proper utilization of video-based resources. Effective classroom use requires planning, previewing, active viewing, and follow-up. The teacher must determine the

lesson's objective: in the above example, it may be to introduce a concept (sole proprietorship). The teacher then plans a lesson which incorporates a viewing activity. Television is most effectively used as a teaching resource when it is actively viewed, i.e., when the teacher and students interact during the viewing. Using the example, the teacher may ask a landmark question, such as, "What Is A Sole Proprietorship?" The teacher may ask students to raise their hand or give some other indication when they know the answer from their viewing. When hands are raised, the teacher can interact; acknowledge their response, ask another question, or offer praise for their response.

Maximum interaction is possible when each classroom is equipped with a 25" - 27" color television monitor/receiver and a VCR or VCP. Taped programming affords more interaction than programming viewed directly off air. The teacher and/or students control the activity level - – –pausing or stopping for input, clarification, or questions; rewinding and replaying for reinforcement or repetition; fast-forward searching for pertinent landmarks. Taped programming facilitates whole class discussions based on particular video segments and/or cooperative learning projects where small groups view or review particular segments. Active viewing classrooms must be equipped for independent control.

Connections:

Planners and educators need to provide classrooms with maximum flexibility in the use of traditional television technology. Schools should have cable or Master Antenna connections which allow for reception of educational cable and/or public television broadcast reception. Classrooms should be planned and wired for maximum autonomy in using video-based resources. Every classroom should be equipped with a permanent minimum 25-27" color TV monitor/receiver and permanent VCR or VCP with direct classroom control.

Classrooms cabled for closed circuit transmissions from the media center have less autonomy in viewing but can have increased control if the media center's VCRs/VCPs can be electronically accessed from the classroom.

DISTANCE LEARNING ACTIVITIES

Overview:

Faced with the challenge of low enrollment classes, teacher shortages and the need to update the skills of education personnel, North Carolina Department of Public Instruction established a satellite network using emerging distance learning technologies to address these issues.

The North Carolina Distance Learning by Satellite Network delivers live, interactive high school instruction and staff development programming throughout the state. (As of April 1992, each county has one designated building to receive staff development programming. Seventy high schools are being served with high school programming.)

Activity Description:

Distance learning is defined as a teaching - learning arrangement in which the teacher and student are physically separated; however, the majority of the learning interactions occur in real time. To this end, each North Carolina receive site is equipped with a one-way video, two-way audio system

High School Instruction:

The classroom facilitator plays an important role in a successful DLS classroom. Local education agencies are required to assign a classroom facilitator who remains in the classroom during the entire instructional period for each credit class being offered. Whether the site has 1 student or 10 students, the job of the facilitator is to provide the everyday guidance and assurance that quality learning situations require. DLS facilitators should not only be comfortable with equipment operation, but be attentive to recordkeeping and committed to the success of the students.

Staff Development Programming:

North Carolina sites vary in administration of the staff development component of the network; however, in general, it is the philosophy of the state agency that satellite delivered teleconferences should supplement and enhance the training offered at the local level. It is strongly recommended that programming be used live and interactively, but local needs and circumstances vary. Many programs can be videotaped for later use. Before videotaping, check the program description for any notation to prohibit this.

It is typically the staff development coordinator's role to establish local guidelines and procedures for use. Yearly, DPI will identify and sponsor selected renewal credit bearing staff development activities. North Carolina sites can use these packages to offer the credit activity locally "as is", or use them as a guide to structure training activities that more closely meet their targeted goals. The DLS telecasts can also be used for professional development/growth plans, personal enrichment, or supplementing local meetings.

Connections:

Equipment for satellite delivered distance learning includes a satellite receive dish (preferably a steerable C/Ku dish), cabling, classroom receive equipment (typically including a 19-25" monitor, videocassette recorder, and tunable receiver), and a telephone handset for program interaction. Classroom equipment should be kept in a locked cabinet or other secure place.

Location for installation of the dish should be in an open area, approximately 12'x12', no more than 225 feet to the classroom. Alternate mountings are to be on an external wall or on the roof. (Roof mounts are least desirable and should be used only after a structural analysis is made to insure that the roof can support both the actual and wind loading weight of the antenna.) Prior to installation local codes should be reviewed for any restrictions.

In the case of ground mounting a 6' security fence with locking gate should be installed. Anticlimb devices or other security measures should be taken for roof mountings.

Classroom space should be large enough to accommodate 10 students comfortably when installation is used for instructional purposes. When staff development is the installation's primary purpose, the room should seat 30-40 persons. In either case the space need not be dedicated. Local education agencies select the location for the distance learning classroom and are required to provide a site manager.

Sites are also required to install and support a separate business phone line to be used for program interaction. In this way students can ask questions of their teachers, hear comments made by students at other locations, and conduct dialogues between receiving sites. Staff development participants can ask questions directly to presenters, including Raleigh-based DPI personnel, and interact with other professionals on a statewide or nationwide basis. Typically these receive site calls are toll-free.

••••Case Studies••••

Case Study 1: The Weather Problem

It is 4:30 a.m. and the principal's home telephone is ringing. Upon answering it, the principal is confronted with the superintendent's gruff voice proclaiming that schools will be closed due to bad weather. This situation would normally call for a pot of coffee and the school's telephone directory. There is usually a legion of people to call. Call the cafeteria workers. Call the janitor. Call the teachers who live over in the next county. Call the bus drivers. Call the local radio station.

Once all the calling is done, there is still the required trip to the school. There is the security system to reset. There are lights to turn off and thermostats to turn down. And somebody should be in the building to answer the phone.

This year the situation is different. With the addition of a six classroom wing came the realization that the old intercom system would not handle the new load and would have to be replaced. A new, fully integrated communication system was installed. The new system not only replaced the intercom system, but it also replaced the old clock system and the old bell system. Furthermore, the new system can do so many more functions.

Now, when the superintendent calls at 4:30 a.m., the principal merely calls a special, unlisted number into the communication system. Using the keypad on the phone, the principal directs the system to make all the necessary phone calls playing a prerecorded message advising the listener of the current conditions. Next, the principal changes the schedule on the security, energy and environmental control systems to "weekend," and instructs the system to direct all incoming phone calls to voice mail which issues a "school closed" message. The principal can then return to bed.

Four hours and half a pot of coffee later, the principal again calls the system and directs it to forward all phone calls to her home phone for the day.

Case Study 2: The Paper Problem

What principal has not experienced the frustration of mundane paper trails? Watching teachers dash about the building trying to gather all the information to be placed on report cards. The librarian stuffing the teachers' mail boxes with lists of students with overdue books. The parade of teachers with their purchase order forms should monies become available. The anguish of the teacher who discovers her film request form got "lost." The conscientious guidance counselor that discovers three different spellings of a student's name. The over-worked secretary with a tower of typing requests. The salvos of students scurrying through the halls, carrying grotesque passes, headed for the media center to find "a" book.

Now fertilize the frustration with daily routines. The janitor with the Houdini touch. Parents looking for their offspring bearing a different sire name. The maintenance crew that stomps in in response to an "urgent" call from an unknown caller.

This need not be the typical school scenario. A telecommunications network can support how students learn. It can also support how teachers work. One master file server with the complete records of all students, accessible to teachers, librarian, guidance counselors, etc., should eliminate any "name" problems. Locks and codes would protect any "private" information from displaying on the wrong screens. Teachers could post grades and comments in files from their workstations. The librarian could post overdue notices to files from the library workstation.

From the classroom, students would have access to the on-line catalog in the library. Teachers could type their reports and letters and then send the data to the laser printer in the control room. A group of students in one classroom could have an electronic interchange with students in another school — in another state. The principal, or any teacher, could pick up the phone and page the janitor for assistance without disturbing any other person in the school.

Case Study 3: The Video Playback Problem

The physical education teacher received a videocassette concerning a health topic that had been a very important and current issue during recent class discussions. The timing of the receipt of the cassette could not have been better.

On this day the teacher had to go to the media center storage area and check out a VCR and television set mounted on a rack with wheels. The main problem was that there were five classes which would be held in five different locations in the school on this particular day. Not only did the rack with the VCR and television set have to be pushed to one classroom, it had to be pushed to five different classrooms.

Moving the rack and television set required not only the teacher but at least one other student to assist in transporting the cart from classroom to classroom. This took time and caused some minor disruptions in the normal activity of the classroom.

So first thing in the morning the teacher went to the media center and checked out the rack with the television set and VCR. She then, with the assistance of a student, rolls it to the first classroom. The class is taught and the video shown. After the class, the teacher with the assistance of a student rolls the cart to the next classroom. This is repeated three more times during the period of the day. The rack with the VCR and television were then returned to the media center.

With a modern integrated telecommunications system, this roving teacher has a much easier task to perform. When the teacher receives the videocassette (it could be a laser disc in the modern school) and takes it to the media center, the cassette is given to the media consultant in charge of communications. The teacher lists the times that she would like the videocassette shown and the various classrooms in which the teacher will be located. The media consultant takes the videocassette and places it into a VCR located in the media telecommunications room, and then hands to the teacher a piece of paper with a few numbers written on it. The teacher then walks confidently and leisurely to the first classroom.

When the time comes to review the videocassette, the teacher turns the attention of the class to the television monitor located near the ceiling in the front corner of the room. The teacher walks to the telecommunications handset located near the door, lifts the handset and enters a code in the keyboard and in about five seconds the videocassette program is displayed on the screen of the television set in the classroom. When the cassette ends, the teacher goes back to the telecommunications handset, removes the handset and enters a code into the keyboard which rewinds the videocassette and has it ready for the next showing. At the end of the class, the teacher leisurely walks to the next class to show the videocassette to that group of students.

When the teacher is ready to show the videocassette program to the next class, she repeats the action of removing the handset from the telecommunications wall-mounted device, punches in a code and the videocassette program appears on the screen of the television set located in the classroom. This scenario is repeated three additional times during the remainder of the day.

Not only can the teacher control the videocassette recorder located in the media center, this teacher can communicate with other teachers through the same wall-mounted telecommunications set. The teacher can relate the fact that this videocassette has been received and will be shown to the class at the appointed time. She can alert various people who may be interested in viewing the videocassette without having to do an all call announcement. She can contact each person directly and individually without disturbing the entire school.

The teacher in the school with the integrated telecommunications system does not have to push a heavy television/VCR cart around the school building, nor request the assistance of a student or another teacher to push the cart. If a student does assist, the teacher normally will have to provide an excuse slip for that student in the event he might be late to the next class. The most difficult task of the day would be the transporting of the videocassette to the media center.

••••Common Questions and Answers••••

1. Q: How big (diameter) should the conduit be to make sure we can add wiring for new technologies?

   A: For cabling entering the building the conduit size varies. For conduit within the building 2 inches will be adequate for most purposes, leaving 40% free space.

2. Q: Should there be more than one conduit — or can different kinds of wires be run in the same conduit?

   A: Power wiring and communication cabling need to be separated.

3. Q: Is there a way to be sure the central control area can be expanded to include technologies we forgot or that may come soon and we just don't know?

   A: There is no rule of thumb. However, leaving some additional space is always advisable.

4. Q: How do you go about costing out systems without overlooking key component costs?

   A: See Section III of this document on cabling design, implementation and use.

5. Q: Can a CCTV system in a school be converted into a telephone access system?

   A: Yes, there are systems on the market that permit telephone access to VCR controls.

6. Q: How can I convince the administration we need phones for telecommunications but assure them we can prevent unauthorized personnel calls?

   A: Through various techniques you can control access for outside calls. In the simplest scenario a standard telephone instrument is not even part of a telecommunications environment.

7. Q: How will the advent of HDTV impact on the installation of telecommunications systems in a school?

   A: HDTV will have no impact on the wiring infrastructure in the school.

8. Q: How do I define who is liable/responsible for what when systems use several vendors?

   A: This issue needs to be addressed in the original contract with each vendor. During the warranty period each vendor then remains liable for responsibilities/specifications spelled out in the contract. At the end of the warranty period, a maintenance contract with one vendor is recommended.

9. Q. Is the difference between indoor and outdoor conduit/cable critical?

   A. Yes. Outdoor cable should be jelly-filled, and, outdoor cabling should be used in any interior areas where moisture may be present. Outdoor conduit is heavy steel or heavy schedule PVC, well-sealed. Indoor conduit is flexible electric metallic tubing (EMT).

DIAGRAMS AND APPENDICES

Many terms associated with telecommunications, telephones, computers, and television are used by lay and technical alike. The following terms and descriptions are presented to establish a common ground for communication between interested, involved parties.

ANSI

Acronym for AMERICAN NATIONAL STANDARDS INSTITUTE, a non-governmental organization that processes, modifies, approves, and publishes data processing standards for voluntary use in the U.S.

ARCHITECTURE

The overall design of a computer or computer system.

ASCII

Acronym for AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE, a standard seven-bit code almost always transmitted with a PARITY BIT (for a total of eight bits per character), established by the ANSI to achieve compatibility between various types of data processing and data communications equipment. ASCII is the most commonly used code for non-IBM equipment.

ASYNCHRONOUS TRANSMISSION

Asynchronous [Data] Transmission is the sending of computer data without having a timing signal. Each character is marked by stop bits.

ATTENUATION

A reduction in amplitude of a signal during data or television transmission. Attenuation is caused by resistance in the communication line and may cause loss of data or degradation of picture.

BALUN

(BALanced/UNbalanced) a device that converts the impedance of one interface to the impedance of a second interface. In television, a balun connects the 75-ohm cable to the 300-ohm screws on the TV set.

BAUD

A unit of measurement that denotes the number of discrete signal elements, such as bits, that can be transmitted per second.

BANDWIDTH

(1) The difference, expressed in hertz, between the highest and the lowest frequencies of a range of frequencies. For example, analog transmission by recognizable voice telephone requires a bandwidth of about 3000 hertz (3 KHz). (2) The bandwidth of an optical link designates the information-carrying capacity of the link and is related to the maximum bit rate that a fiber link can support. [Source: IBM Document]

BASEBAND

(1) A frequency band that uses the complete bandwidth of a transmission medium. (2) A method of data transmission that encodes, modulates, and impresses information on the transmission medium without shifting or altering the frequency of the information signal. [Source: IBM Document]

BROADBAND

Synonymous with wideband. (1) A frequency band between any two non-zero frequencies. (2) A frequency band divisible into several narrower bands so that different kinds of transmissions such as voice, video, and data transmission can occur at the same time. [Source: IBM Document]

BUFFER

Also known as a spooler. An area of storage used to temporarily hold data being transferred from one device to another. A buffer is used to compensate for the different rates at which hardware devices process data. A spooler is used to hold data waiting to print, so you can use the CPU for other tasks, since it processes data at a much faster rate.

BUILDING CABLE

The permanently installed cable within a building that interconnects offices to wiring closets, wiring closets to wiring closets, and wiring closets to computer rooms. [Source: IBM Document]

BUS NETWORK

See TOPOLOGY

CARRIER

A transmission signal with a specific wavelength or frequency onto which information or data is modulated.

CATV

See TELEVISION DISTRIBUTION

CAU

See TOPOLOGY

CCTV

See TELEVISION DISTRIBUTION

CD-ROM

Compact Disk - Read Only Memory. An optical disk using holographic principles to store instructions, programs, or other computer code. The disk is read by a laser scanner. CD's can be damaged physically; but it is almost impossible to damage the code. See also WORM

CHANNEL

(1) A functional unit, controlled by a host computer, that handles the transfer of data between processor storage and local peripheral equipment. (2) A path along which signals can be sent. (3) The portion of a storage medium that is accessible to a given reading or writing station. (4) In broadband transmission, a designation of a frequency band 6 MHz wide. [Source: IBM Document]

COAXIAL CABLE

Coaxial cable, or coax, is a type of wire with two conductors within the same jacket. The center conductor is a single strand of wire, usually solid copper, or copper clad steel. Surrounding the center conductor is an insulating material—dielectric—made of foamed polyethylene. Covering the dielectric is an aluminized polymer tape which forms the shield, or second conductor—outer axis—of the "co-axial" cable. A second shield of bare aluminum braid is woven over the tape to give the cable mechanical strength. The cable is protected with a jacket of noncontaminating polyvinylcloride (PVC).

All coaxial cable used in television work must have an impedance of 75-ohms. The impedance of a cable is a measure of how the cable reacts electronically when a signal is passed through it. Impedance is determined by the relationship between the diameters and circumferences of the co-conductors. Coax can have almost any overall diameter as long as the proper impedance relationship is maintained between the inner and outer axes. Cable that is bent too sharp or otherwise mishandled during installation or use, can lose this relationship resulting in transmission loss of certain portions of the RF spectrum.

CONFIGURATION

(1) The arrangement of a computer system - hardware and/or software - or network as defined by the nature, number, and chief characteristics of its functional units. (2) The devices and programs that make up a system, subsystem, or network. [Source: IBM Document]

CROSSTALK

A signal from an adjacent channel that interferes with your data transmission, causing errors.

CRT

Cathode Ray Tube. A vacuum tube that shoots a stream of electrons onto a fluorescent screen causing the fluorescent material to give off light. Magnetic pulses are used to direct the stream. Commonly called a picture tube.

CSMA/CD

Carrier Sense Multiple Access/Collision Detection. A protocol or method of inserting data on a LAN without interfering with messages that may already be on the system.

dBmV

The term decibel (dB) comes from a mathematical formula used by early telephone and telegraph engineers and has been adapted for **television**. The decibel is a logarithmic ratio between two voltages which represent changes of signal in a system. It has no absolute value. It merely tells how many times greater or smaller a quantity is from a preestablished reference level. An increase of 6dB of signal doubles the voltage in the system. The zero reference level is 1,000 microvolts (1 millivolt (mV) measured across 75-ohms of impedance.

DEMODULATOR

A device that removes the carrier from a transmitted analog signal. It may also convert the demodulated signal to a digital signal.

DTMF
Dual Tone, Multi-function. A type of telephone that can dial either pulse or tone and has several functions built-in (e.g., hold, auto-redial and emergency numbers placed in memory).

FDDI
Fiber Distributed Data Interface. A high-performance, general-purpose, multi-station network designed for efficient operation with a peak data transfer rate of 100 Mbps. It uses token-ring architecture with optical fiber as the transmission medium over distances of several kilometers. [Source: IBM Document]

GATEWAY
A computer system with special software that is used to connect two different networks (LANs). The gateway translates all protocols and applications in both directions to facilitate the interconnection between the networks.

IDF
Intermediate Distribution Frame. A framework of connecting panels where riser cables from the MDF or cables coming from or going to other IDFs are terminated. Horizontal cables going to work stations are also terminated on cross-connect fields.

ISDN
Integrated Services Digital Network is a set of evolving international standards for integrated voice, video and data networks. A sophisticated service offered by telephone companies. ISDN offers many capabilities and services including the simultaneous transmission of voice, video and data over the same lines.

ITFS
See TELEVISION TRANSMISSION

LAM
See TOPOLOGY

LAN
See TOPOLOGY

MATV
See TELEVISION DISTRIBUTION

MAU
See TOPOLOGY

MDF
Main Distribution Frame. That point in a communication system where circuit administration takes place. The frame is a metallic structure on which the switch hardware is hung. The hardware includes the various connecting panels where riser cables going to other distribution frames, and horizontal cables going to work stations are terminated on cross-connect fields. The trunk lines from the central telephone office are terminated on main distribution frame inter-connect panels.

MODEM
Acronym for Modulator-Demodulator, a device that converts digital data output from another device, such as a computer or a terminal, into analog data that can be transmitted over the communication lines. It also converts analog data into digital data that can be accepted by another device, such as a computer or terminal.

MODULATOR
A device that converts digital data to analog signals or takes analog signals and integrates the signals onto a carrier for transmission either on a wire or through the air.

MONITOR
See TELEVISION DISPLAYS

MONITOR/RECEIVER
See TELEVISION DISPLAYS

MTBF
Mean time between failures, a measure of the reliability of a piece of equipment specified by the average time it continues to function without a failure.

MUX
An industry recognized shortened word for multiplexer.

NODE
See TOPOLOGY

PBX/PABX
Private (Automatic) Branch Exchange. A privately owned, miniature telephone system that functions within a site. It has its own switch and provides the same services and functions of a regular central office. It has one point of connection to the "outside world" via a trunk line from the central office.

PUNCHDOWN BLOCKS
That part of the cross-connect field or patch panels where the individual wires within a horizontal cable are physically attached. The connecting devices are split metal and the wires are "punched down" into the split, cutting through the insulation and making contact with the conductor.

RECEIVER
See TELEVISION DISPLAYS

RING NETWORK
See TOPOLOGY

RF
See TELEVISION TRANSMISSION

SERVER
See TOPOLOGY

STAR NETWORK
See TOPOLOGY

STP
See UTP

SYNCHRONOUS TRANSMISSION
Synchronous [Data] Transmission is the transmission of data between two devices that are controlled by a common clock signal.

T1
T1 is a capacity reference for telephone lines used to carry voice and data. Twenty-four voice circuits are multiplexed to provide the capacity of 1.544 MB/Sec.

TASO
The Television Allocations Study Organization. (*See Appendix for TASO Chart.*)

TELEVISION DISPLAYS:

MONITOR - A monitor is a special type of high quality television set used specifically in video reception, rather than RF. Video monitors are not tunable to channels, and must be used with video sources. They normally have no provision for sound reception. As purely professional equipment, video monitors have heavy duty internal components and use picture tubes with narrower angles of deflection than RF receivers.

MONITOR/RECEIVER - A monitor/receiver is a high quality RF receiver and low quality video receiver. A monitor/receiver looks and functions much like a standard television receiver. The RF signal detection circuits (tuners), however, may be by-passed enabling the receiver to process video.

RECEIVER - A receiver is any television set, though more specifically, one designed for RF channel reception of sound and picture. It may be either a standard "home set" or one designed especially for classroom use.

TELEVISION DISTRIBUTION:

CATV - Community Antenna Television - cable television - is a system designed to provide television service to an entire community. The basic idea is to erect receiving antennas at a site where good quality TV signals are available. These signals are then relayed to the community and distributed to individual subscribers via coaxial cable.

CCTV - Closed Circuit Television is unique in that it uses coaxial cable, microwave, or satellites to transmit signals to predetermined receivers, unlike public broadcast which transmits to nonselective receivers. Thus, CCTV can exercise control over its reception and utilization. CCTV is also that portion of a school television system that handles the transmission of videotaped information and locally originated telecasts. There are other applications of CCTV in connection with security and surveillance systems.

MATV - A Master Antenna Television system delivers television signals to two or more TV sets from a common or master antenna. An MATV system is usually confined to one building or facility. The same basic design and construction technology as used in CATV systems is now being used in MATV systems. Advances in component design now make it possible for MATV systems to carry over 35 channels. Presently, MATV systems are not regulated by the F.C.C.

TVRO - Television Receive Only is a phrase associated with the hardware of a satellite TV reception station. The hardware consists of a parabolic dish antenna, a feedhorn, a Low Noise Amplifier (LNA), a block down converter, and a receiver. It can also be called a down-link or earth station. Earth station, however, can also mean a satellite transmitting station or up-link.

TELEVISION TRANSMISSION:

ITFS - Instructional Television Fixed Service is a type of low powered broadcasting, at super ultra high frequency (2500-2690 MHz), for the use of local education agencies. It provides an inexpensive point-to-point school service that is limited to small coverage areas and must be received by pretuned, multiplex equipment. There are usually four separate channels in one ITFS package. ITFS is supported by the local institutional licensee.

RF - Radio Frequency - A system of through-the-air transmission, or broadcast, utilizing tuned bandwidths of the radio spectrum, each 6-MHz wide, to carry both audio and video signals. RF can also be transmitted over a coaxial cable. The advantage with RF is that several programs (audio + video) can be transmitted and received simultaneously throughout a [school] over a single coaxial cable. The disadvantage is in the relatively lower picture quality obtainable when compared with video because of bandwidth restrictions.

The RF spectrum for through-the-air transmission is divided into VHF and UHF. VHF is further divided into low band and high band. Low band includes channels 2 through 6 and FM radio. The spectrum from 54 MHz to 72 MHz covers channels 2, 3, and 4; and the spectrum from 76 MHz to 88 MHz covers channels 5 and 6. The 4-MHz band between channels 4 and 5 (a guard band) is used for RC airplanes, boats, cars and other toys. Immediately following channel 6 is FM radio which covers 88 MHz to 108 MHz.

High band includes channels 7 through 13 which covers from 174 MHz to 216 MHz. The spectrum from 108 MHz to 174 MHz is used for governmental, commercial and amateur radio communications.

UHF begins with channel 14 at 470 MHz and ends with channel 83 at 892 MHz. Usually channels 71 through 83 are used for special TV transmissions between the studio and the transmitter site.

When RF is transmitted through a coaxial cable, it is confined to the cable and does not radiate through the air. Hence, those portions of the spectrum allocated to communications other than television can be used for television on the cable. Thus, the spectrum from 12 MHz to 52 MHz is called sub-band and covers six channels. Many cable television companies use this portion of the spectrum for data transmissions.

Mid-band, channels A through I, or cable channels 14 through 22, uses the 120 - 174 MHz portion of the spectrum. Super-band, channels J through W, or cable channels 23 through 36, uses the 216 - 300 MHz portion of the spectrum. Some cablecasters are trying to use the 300 - 456 MHz portion, Hyper-band, for an additional 26 channels. Because frequencies above 300 MHz require so much power for long distance cable transmission, Hyper-band is not very cost effective with today's technology.

TRANSLATOR - A translator is an electronic apparatus which receives a broadcast RF signal, changes its frequency and rebroadcasts it. Translators range between 1 and 1000 watts in power and seldom go over 100 feet above the ground. Translators are used to supply broadcast signals to areas shielded from transmitter signals by man-made and/or natural obstacles.

TRANSMITTER - A transmitter is an electronic apparatus used to generate and modulate a radio frequency which is then conveyed to an antenna for broadcasting as electromagnetic waves. Television transmitters usually operate between 100 Kw and 2500Kw in power. The antenna is usually between 300 and 2000 feet above the ground.

VIDEO - A system of transmitting television pictures, over a coaxial cable utilizing bandwidth frequencies from zero (0) to 10 megahertz (MHz) to carry the signals. Unlike Radio Frequency, there is no channel tuning and no sound transmitted over the cable. Only one video signal at a time can be transmitted over a cable; hence, there is no necessity to restrict horizontal resolution to a fixed maximum. Picture quality is superior to that of RF, but the range of transmission is comparatively short and requires more frequent line amplification. Normally, a separate audio cable must be used for sound.

TERMINAL

A device used to send and receive data from a computer system, especially such a device with a keyboard and an attached CRT and/or printer. Terminals can be located at great distances from the computer, connected by any of various communications lines.

TOKEN RING

See TOPOLOGY

TOPOLOGY:

The logical or physical placement of nodes. For example, ring, star, bus, tree. Sometimes called the network configuration.

BUS NETWORK - A LAN in which the work stations are connected along a common line.

CAU - Controlled Access Unit, often used in a Token Ring network. A group of computer terminals are connected to a CAU. Computer signals are amplified by the CAU before injecting them into the network. A CAU usually connects into a LAM.

LAM - Lobe Attachment Module. A device that works with a CAU to connect up to 20 computer terminals to a network.

LAN - Local Area Network, a product that allows multiple users to connect to a single conductor and communicate with each other without interference. Local implies that the network's range is limited - usually to less than a mile.

MAU - Multistation Access Unit. A device used in a Token Ring network to connect up to 8 computer terminals to the network. The MAU passes the computer signals on to the network.

NODE - A point in a LAN at which one or more functional units connect to the transmission lines in order to communicate with other units in the network. Functional units may be individual computers, computer systems, printers, etc.

RING NETWORK - A LAN network in which the various terminals are computers are linked together in a circular pattern, with each connected to the two nearest to it.

SERVER - A LAN component that provides resources to the network to be shared by other network users. Servers are identified by the type of resource they provide (e.g., disk server, file server, printer server, communications server).

STAR NETWORK - A LAN network in which all communications between various computers and terminals takes place through a central computer. The cables run out from the central unit - hub - file server - like points of a star.

TREE NETWORK - A LAN in which various terminals and computers are linked to a main computer in a hierarchical manner, with each additional device branching from one of a higher level.

TOKEN RING - A LAN architecture that connects stations in a closed loop and grants permission to send by circulating a token that users may acquire and replace with a message. Token passing ensures that every station has an opportunity to transmit, but that no two stations transmit at once.

TRANSLATOR

See TELEVISION TRANSMISSION

TRANSMITTER
See TELEVISION TRANSMISSION

TREE NETWORK
See TOPOLOGY

TVRO
See TELEVISION DISTRIBUTION

VIDEO
See TELEVISION TRANSMISSION

UNCCPTV
University of North Carolina Center for Public Television. Headquartered in Research Triangle Park, the UNCCPTV is responsible for the mechanical operation of a public television broadcast network across the state. During late afternoons, evenings, and weekends it broadcasts PBS programming. During weekdays, it broadcasts a series of programs supplied by the State Department of Public Instruction. (*See Appendix for Channel Allocation Chart.*)

UPS
Uninterruptible Power Supply. A device that senses voltage fluctuation on the external power supply. Should the voltage fluctuate beyond set limits, a special battery is switched into the supply circuit permitting an orderly closedown of the operation.

UTP
Unshielded Twisted Pair. A transmission medium that consists of two insulated conductors twisted together to reduce noise. [Source: IBM Document]

Some types of data transmission - voice - use unshielded twisted pair (UTP); while other types of data transmission - IBM Token Ring - use shielded twisted pair (STP). Research shows that the number and style of twists are critical to application.

WORKSTATION
Any I/O device that allows either transmission and/or reception of data from the host system, as needed to perform a job. A workstation may be where an operator works or it could be a printer or remote display device.

WORM
Write Once, Read Many. An optical compact disk on which you can write data once. The disk can then be read many times. A popular way of storing archival data. WORM machines use a different technology than CD-ROM machines. The two machines are not interchangeable.

YAGI ANTENNA

A type of television receive antenna designed for optimum performance on one particular channel. All the elements are cut to a length proportional to, and located on the boom according to the wavelength of that channel. A yagi antenna is usually characterized by high gain and a narrow reception pattern.

COMPUTER FACILITY PLANNING GUIDE

"The special needs of a computer facility impact upon acceptance, use, teaching and learning. If teachers are required to use poorly designed computer facilities for instruction, they must modify their instruction to compensate for the effects of the design. For the students, poor design means they must twist, turn, and stretch in order to see the board, work with handouts and references, or even operate the computer....Thoughtful advance planning assures that the classroom is systematically designed to promote both teaching and learning."

Sales, Educational Technology, May, 1985, p.7.

"Accommodating numerous computers—along with printers and hard disks and networks—requires more sophisticated planning than does simply putting a computer on a table in the back of the room. Facilities planners must address unique issues of electrical power and network access, as well as appropriate furniture and lighting."

T.H.E. Journal MAC Special Issue 1990

The following guidelines are intended to give general directions and may not apply to every situation.

ROOM - SELECTION

_____ 1. Rectangular room with no partitions or dividers.

_____ 2. Adequate space (40 square feet) for each anticipated workstation which includes table, chair, and circulation area.

_____ 3. Central location in terms of accessibility by teachers and students and in the vicinity of the media center.

_____ 4. Windowless room to prevent glare on video display and to minimize security problems. However, windowless rooms are required to have two doors on opposite sides of the room for fire safety consideration. (Revised, May 1992)

_____ 5. Location away from highly visible, heavily traveled areas to prevent security problems.

_____ 6. Convenient location accessible to bathrooms to help accommodate after school activities such as teacher in-service and adult education sessions.

ROOM - PREPARATION

_____ 1. Security devices such as lock on door with unduplicated key, locks on windows, etc.

_____ 2. Security system for room or building (optimum).

_____ 3. Opaque window shades, blinds, or curtains, easily controlled to reduce glare where windows cannot be eliminated.

_____ 4. Light-colored, low-gloss paint on walls to reduce reflected glare and reduce need for bright overhead lighting.

_____ 5. Recessed or indirect overhead lighting to reduce glare.

_____ 6. Indirect light levels of 40 to 50 foot-candles or recessed fluorescent lighting fixtures with parabolic louvers using a grid of less than 1". (Revised May 1992)

_____ 7. Hardwood, vinyl, or anti-static carpeting on floors to reduce static electricity. Avoid dust-producing concrete floors.

_____ 8. Electrical power supply on separate circuit from other areas and equipment. Furnaces, stoves, shop equipment, or appliances with large power consumption rates can cause power fluctuations which may damage equipment, cause equipment malfunctions, or destroy data.

_____ 9. Four grounded receptacles (CPU, monitor, printer, and one other peripheral) within 4 feet of each workstation and seven receptacles within 4 feet of the teacher workstation. The teacher workstation may be equipped with any of the following: CPU, printer, monitor, LCD panel, overhead projector, CD-ROM drive, VCR, videodisc player, external hard disk, modem, etc.

_____ 10. Three (typically) amps of electrical power at each workstation with a maximum of 15 amps on any circuit.

_____ 11. Line boosters, anti-surge protectors, or uninterrupted power supplies (UPS) on computer outlets to prevent data loss, interrupted data transmissions, or damage to hardware.

_____ 12. Master switch(es) to control power to workstations.

_____ 13. Master switch to control lighting level for different instructional situations such as when using printed materials, LCD panel and overhead projector, computers, etc.

_____ 14. A separate temperature control for the computer lab in order to provide a relatively stable temperature between 60°F and 80°F with no greater change than 15 degrees per hour.

_____ 15. Dust filters on air vents.

_____ 16. Dust covers on hardware to avoid collection of dirt, chalk dust, pollen, etc.

_____ 17. Relative humidity between 40% and 60%. High humidity promotes oxidation on disk drive heads and electrical connections.

_____ 18. Acoustical treatment for noise control.

_____ 19. Ceiling tiles in good condition. Brittle, old ceiling tiles may fall on equipment or produce tile dust that can enter hardware through vent slots or cooling screens.

_____ 20. Wall boxes/outlets for voice/video/data should be 4" by 4" extra deep.

EQUIPMENT - LOCATION

_____ 1. Computers away from devices which cause magnetic fields. (electric motors, audio speakers, television receivers, magnets, etc.)

_____ 2. Computers where sunlight will not strike the monitor screens and cause glare. Turning up brightness controls on monitors to compensate for glare reduces the life expectancy of the cathode ray tube (CRT).

_____ 3. Hardware away from potential water damage from leaking roofs, radiators, sinks, water fountains, etc.

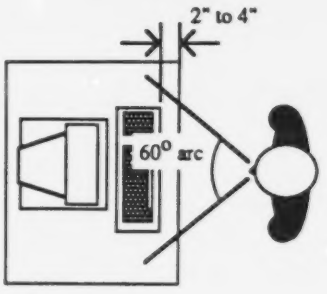
_____ 4. Hardware along eastern or northern walls where summer sun cannot cause overheating.

_____ 5. Printers away from walls adjoining other classrooms because of the vibration and noise they produce.

_____ 6. Arrangement for three work areas:
- Student workstations with sufficient space between rows to allow the teacher and others to move freely around the room.
- Work area at rear or side of room for non-computer activities.
- Teacher presentation station with space that permits the use of an overhead projector and LCD panel and/or large screen monitor for easy class viewing. *(See attached diagrams).*

_____ 7. Keyboards positioned for typing so that the user's elbow is bent at an angle between 80° and 120° while typing.

_____ 8. Seating to allow the computer user to be seated at least arms length from his/her monitor and four feet from anyone else's to decrease VDT emissions (ELECTRONIC LEARNING, October 1990, Bill Morgan, page 14).



_____ 9. Center of video screen 10° - 20° below the horizontal of the user's eyes to prevent sore neck muscles by promoting good posture and reducing head movement when referring between screen and printed material.

_____ 10. Equipment, which is used most frequently, in the central field of vision (60° arc) and within easy reach (2" - 4" from front edge of table). (See diagram.)

_____ 11. Video screens in a position to avoid distracting others.

FURNITURE - TABLES

_____ 1. Adjustable table legs to suit size and personal preference of individual users and promote good posture, with openings for cables to drop to floor.

Tables (working surface)

GRADE LEVEL	HEIGHT	WIDTH	DEPTH
Elementary	22-26"	54-60"	24-36"
Middle	23-28"	54-60"	24-36"
High	26-28"	54-60"	24-36"

_____ 2. Storage shelves as part of the table for manuals, supplies, student belongings, etc.

_____ 3. Space at each table to accommodate two chairs comfortably (54") without interference from the table legs (36" minimum width).

_____ 4. Light-colored, no-glare finishes to reduce eyestrain caused by the contrast between the workstation surface and printed reference material.

_____ 5. Modesty panel to keep walls clean and computer cords safe.

_____ 6. Sturdy tables, large enough to support a computer system and student materials, as well as allow space for work.

_____ 7. No casters that discharge static electricity.

_____ 8. Lockable furniture with casters for mobile units for security and flexibility of computer use.

_____ 9. Wireways and cable trays instead of conduit to carry all low voltage cabling.

FURNITURE - CHAIRS

_____ 1. Adjustable chairs for body and back height to maximize comfortable working position.

_____ 2. Chair height to allow a knee-bend angle of 90°.

Chairs

GRADE LEVEL	HEIGHT
Elementary	11-15"
Middle	13-16"
High	16"

_____ 3. Chair that includes shelf or rack under seat for storage of student items. (Optional)

_____ 4. Chairs with rollers for added flexibility of movement.

FURNITURE - MISCELLANEOUS

_____ 1. Adequate shelving for reference books, software documentation, and texts.

_____ 2. Storage for disks, printer paper, and equipment not in use.

_____ 3. Some lockable storage space.

_____ 4. Shelving and storage easily accessible without interrupting class.

_____ 5. Bulletin board(s) with instructions for the operation of hardware and software located near computers.

_____ 6. Marker boards, rather than chalkboards, to prevent dust.

_____ 7. Storage for diskettes at temperatures between 50° F and 125° F.

_____ 8. Document holder at each computer to reduce neck strain when the student is typing information into the computer from a printed copy. (Optional)

_____ 9. Tall cart or wall mounted large television/monitor.

EQUIPMENT - TELECOMMUNICATIONS/NETWORKING

_____ 1. Isolated or dedicated telephone line near teacher station in each classroom in the computer labs, and in appropriate locations in the media center.

_____ 2. Wiring/telecommunication closets should be located in each building (excluding storage) of a school complex. The closet should contain the mechanical terminations for a portion of both the horizontal and the riser wiring systems, as well as support for the passive and active devices to interconnect the horizontal-riser systems. *(See NCDPI Guidelines to Provide Uniform Wiring Service for Telecommunications in North Carolina Public Schools for details)*

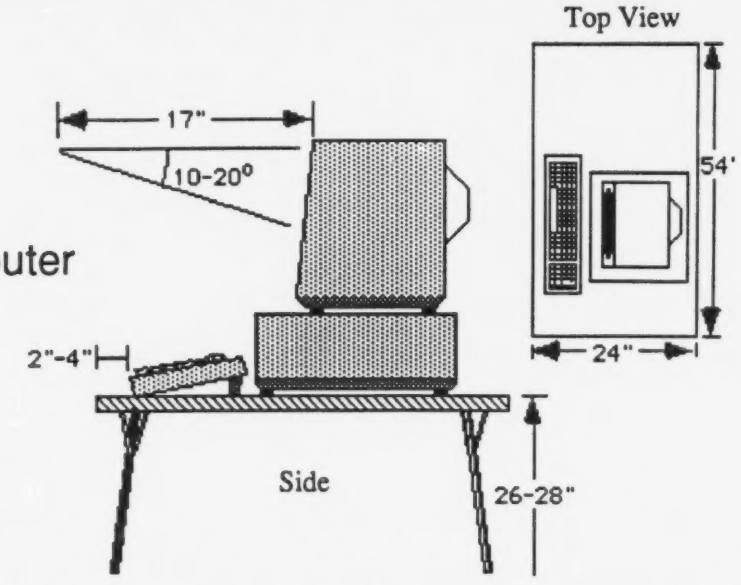
_____ 3. Wall wiring should conform to NCDPI Guidelines to Provide Uniform Wiring Service for Telecommunications in North Carolina Public Schools for both conduit and wireways/cable trays. Wireways and cable trays are recommended for low voltage cabling. Pull boxes for conduit and hinged side covers for wireways are necessary for access to cable installations/modifications.

_____ 4. Conduit size and type should conform to specifications in the NCDPI Guidelines to Provide Uniform Wiring Service for Telecommunications in North Carolina Public Schools, with riser conduit a minimum of 3 inches, horizontal conduit a minimum of 1 inch, and entrance conduit a minimum of 2 inches.

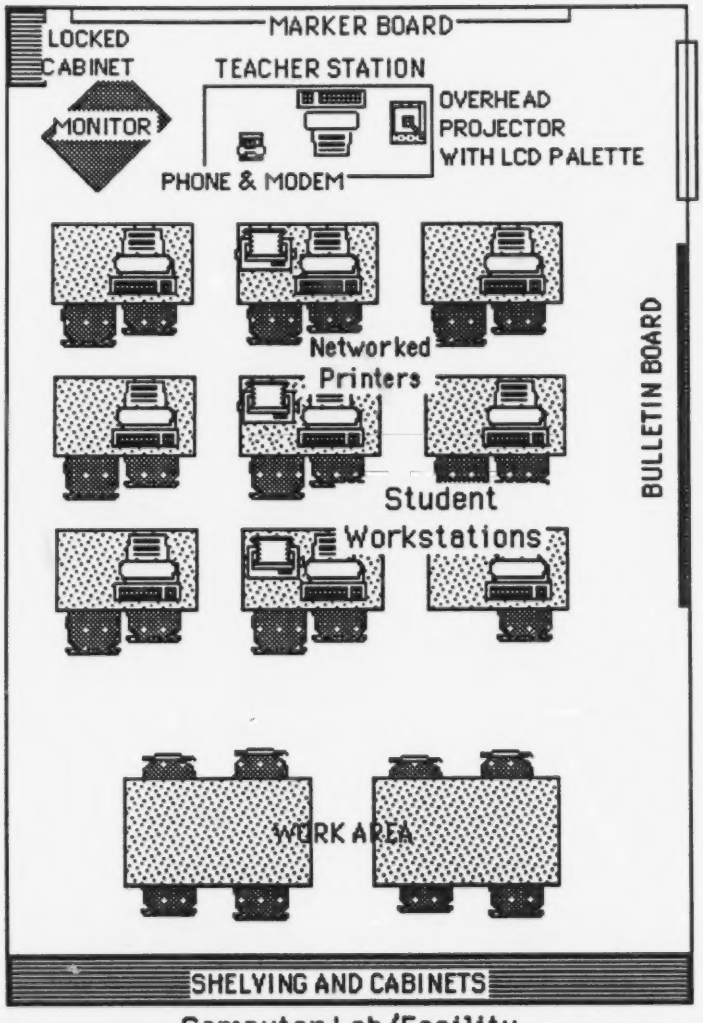
_____ 5. Data outlets/wall boxes should be available in a 4" x 4" extra deep size to provide voice, video (digital), and data. Wall boxes for classroom televisions or networked videodisc applications (analog) should also be 4" x 4" or can be a standard 2" x 4" duplex box. *(See NCDPI Guidelines to Provide Uniform Wiring Service for Telecommunications in North Carolina Public Schools for details)*

DIAGRAMS

Two Person Computer Workstation



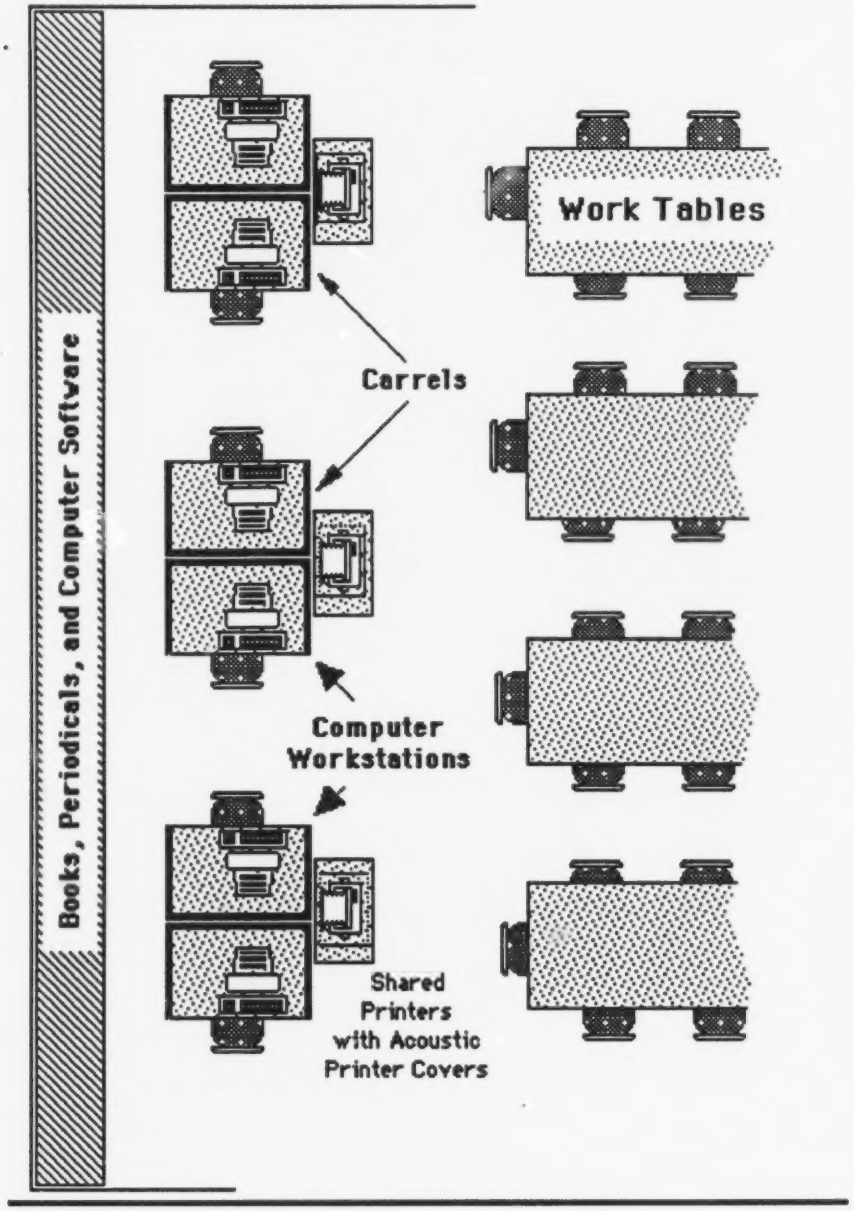
Two Person Computer Workstation



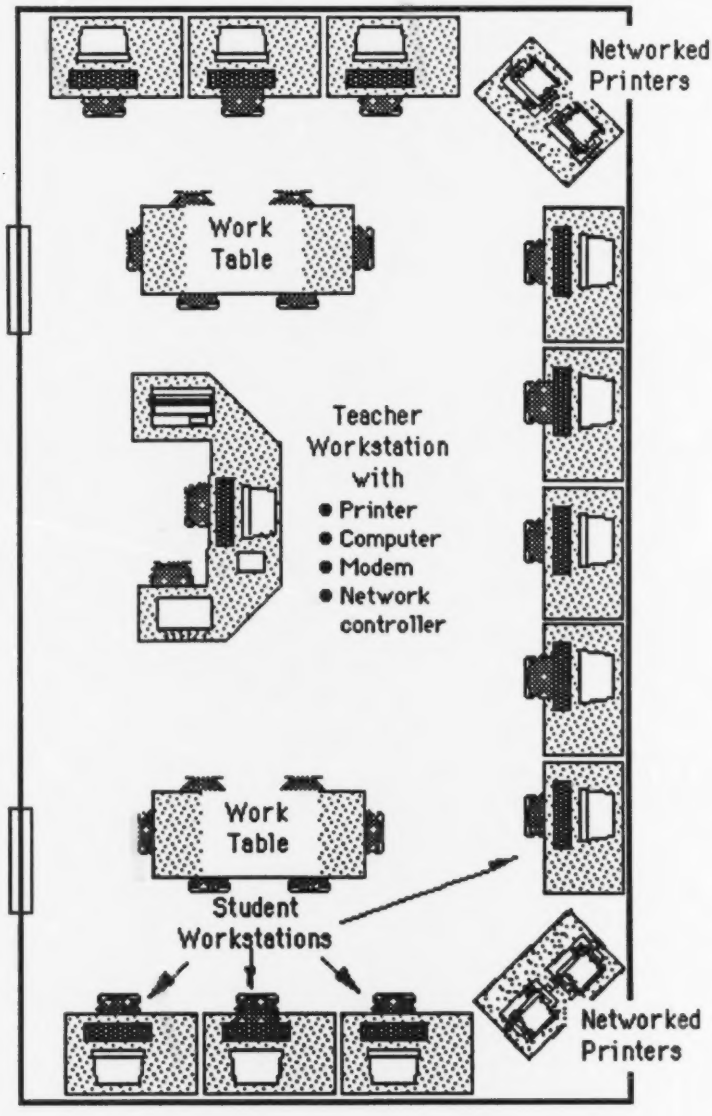
Computer Lab/Facility

Computer Lab/Facility

Option: Student stations could be configured differently such as continuous surface instead of separate tables.

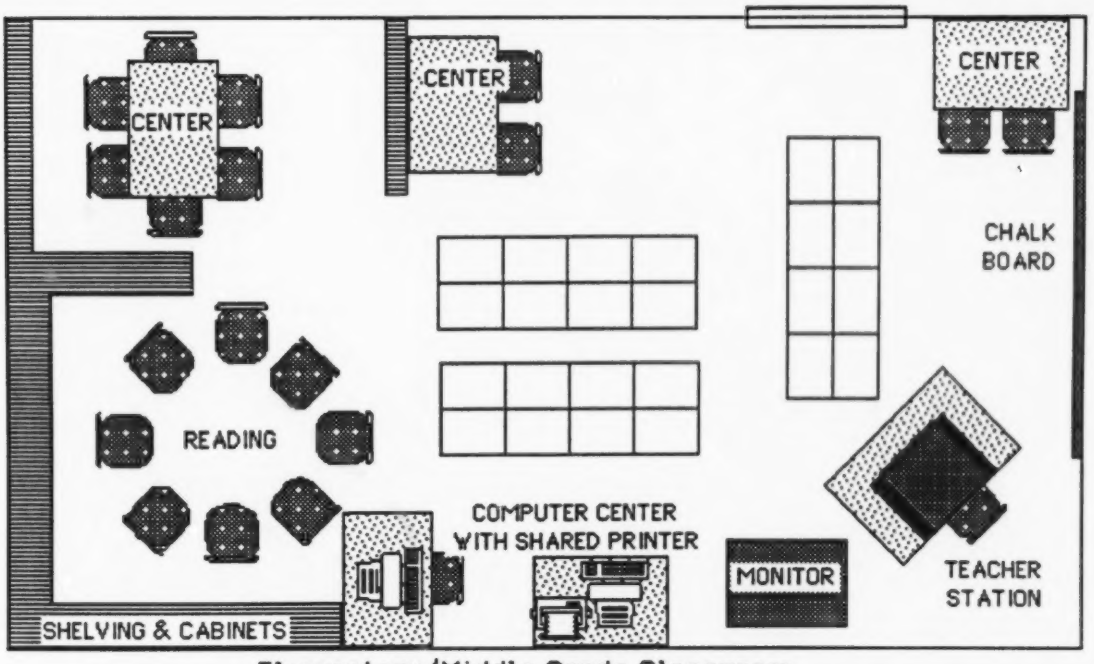


Media Center
Student Workstations

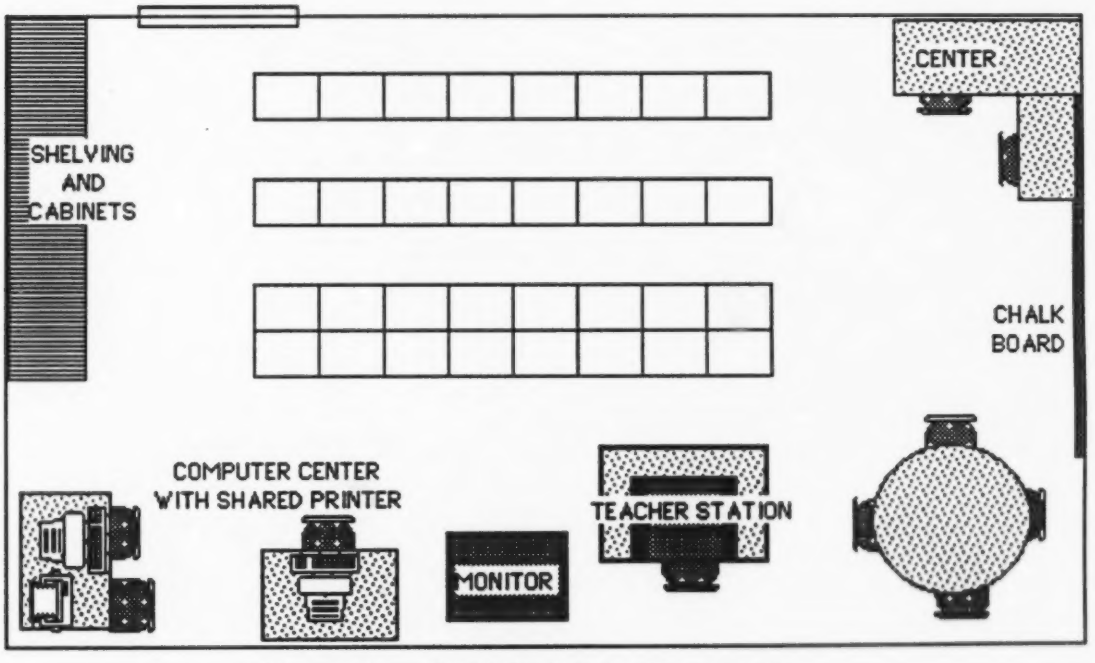


Computer Lab

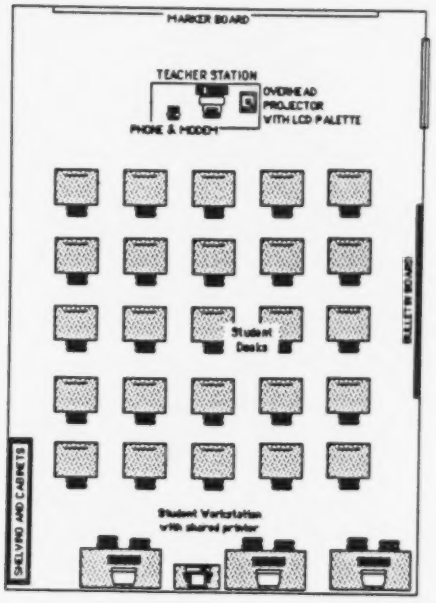
Option: With fewer computers, this configuration could be a mini-lab within a media center or resource room.



Elementary/Middle Grade Classroom

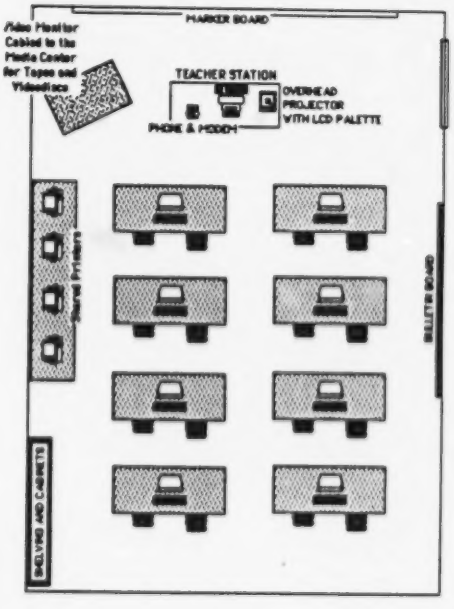


Elementary/Middle Grade Classroom



High School Classrooms

Options: High School classrooms might be equipped with laptop computers for check-out. Computers also may be networked to a central file server for sharing software and work files.



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TASO

The Television Allocations Study Organization was a special committee selected and assembled to study picture quality as it relates to perceptible noise (snow). The results of the study have become the measure whereby all television pictures are judged. The chart below shows the relationship between TASO grade and the signal-to-noise (S/N) ratio.

GRADE	NAME	DESCRIPTION	S/N RATIO
1	Excellent	Picture is of extremely high quality, as good as you could desire.	44 dB
2	Fine	Picture is of high quality providing enjoyable viewing. Interference is perceptible.	34 dB
3	Passable	Picture is of acceptable quality. Interference is not objectionable.	28 dB
4	Marginal	Picture is poor in quality and you wish you could improve it. Interference is somewhat objectionable.	23 dB
5	Inferior	Picture is very poor but you could watch it. Interference is objectionable.	17 dB
6	Unusable	Unusable	- -

A TASO 1 or 2 picture quality is desirable for classroom use. A TASO 3 picture, while perfectly acceptable for recreational viewing, is border-line for classroom use because of the high attentiveness levels. The poorer the TASO grade the sooner the viewer will mentally detach from the program.

NCPT

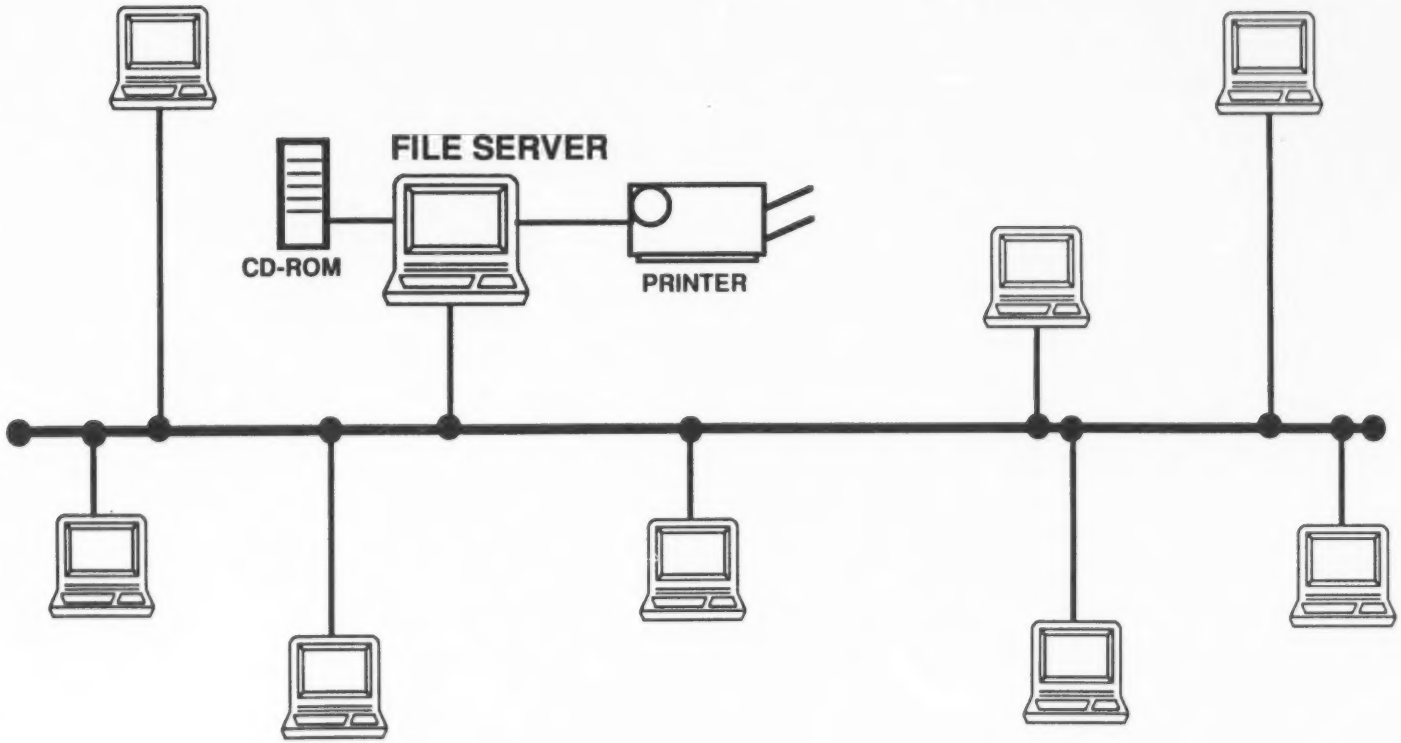
University of North Carolina Center for Public Television.

CHANNEL	CALL SIGN	LOCATION	PHONE	
TRANSMITTERS:				
2	WUND-TV	Columbia	919-797-4317	919-549-7202
4	WUNC-TV	Chapel Hill	919-933-2080	919-549-7204
17	WUNE-TV	Linville	704-733-2066	919-549-7217
19	WUNM-TV	Jacksonville	919-448-1491	919-549-7219
25	WUNK-TV	Greenville	919-753-5541	919-549-7225
26	WUNL-TV	Winston-Salem	919-983-9642	919-549-7226
33	WUNF-TV	Asheville	704-235-9133	
36	WUNP-TV	Roanoke Rapids	919-586-5218	919-549-7236
39	WUNJ-TV	Wilmington	919-253-4191	919-549-7239
58	WUNG-TV	Concord	704-536-4413	919-549-7258
31	WUN?-TV	Lumberton - Waiting Funding		
53	WUN?-TV	Rockingham - Proposed		
TRANSLATORS:				
5	W05AU	Bat Cave	Chimney Rock	
23	W23AF	Cullowee	Brown Mtn	
24	W24AU	Cashiers		
27	W27AX	Lake Lure		
27	W27AB	Canton/Waynesville	Chambers Knob	
28	W28AN	Franklin II	Wine Springs Bald	
31	W31AN	Murphy	Will Scott Mtn	
35	W35AD	Sparta	Brown Mtn	
42	W42AX	Bakersville	Locust Knob	
43	W43AU	Marion (new)	Mt. Ida	
46	W46AG	Boone	Cone Mtn	
52	W52AQ	Black Mountain	Flat Top Mtn	
56	W56AG	Franklin/Sylva	Cowee Bald	
56	W56AN	Tryon/Saluda	Tryon Peak	
59	W59AD	Andrews/Murphy/Robbinsville	Joanna Bald	
59	W59AK	Spruce Pine	Woody's Knob	
59	W59AR	Brevard	Rich Mtn	
59	W59AK	Zionville		
62	W62BA	Hayesville	Davy Mtn	
62	W62BB	Highlands *	VZ Top	
65	W65AT	Marion *	Mt. Ida	
67	W67AQ	Burnsville *	Phillips' Knob	
67	W67AV	Bryson City *	Potato Hill	

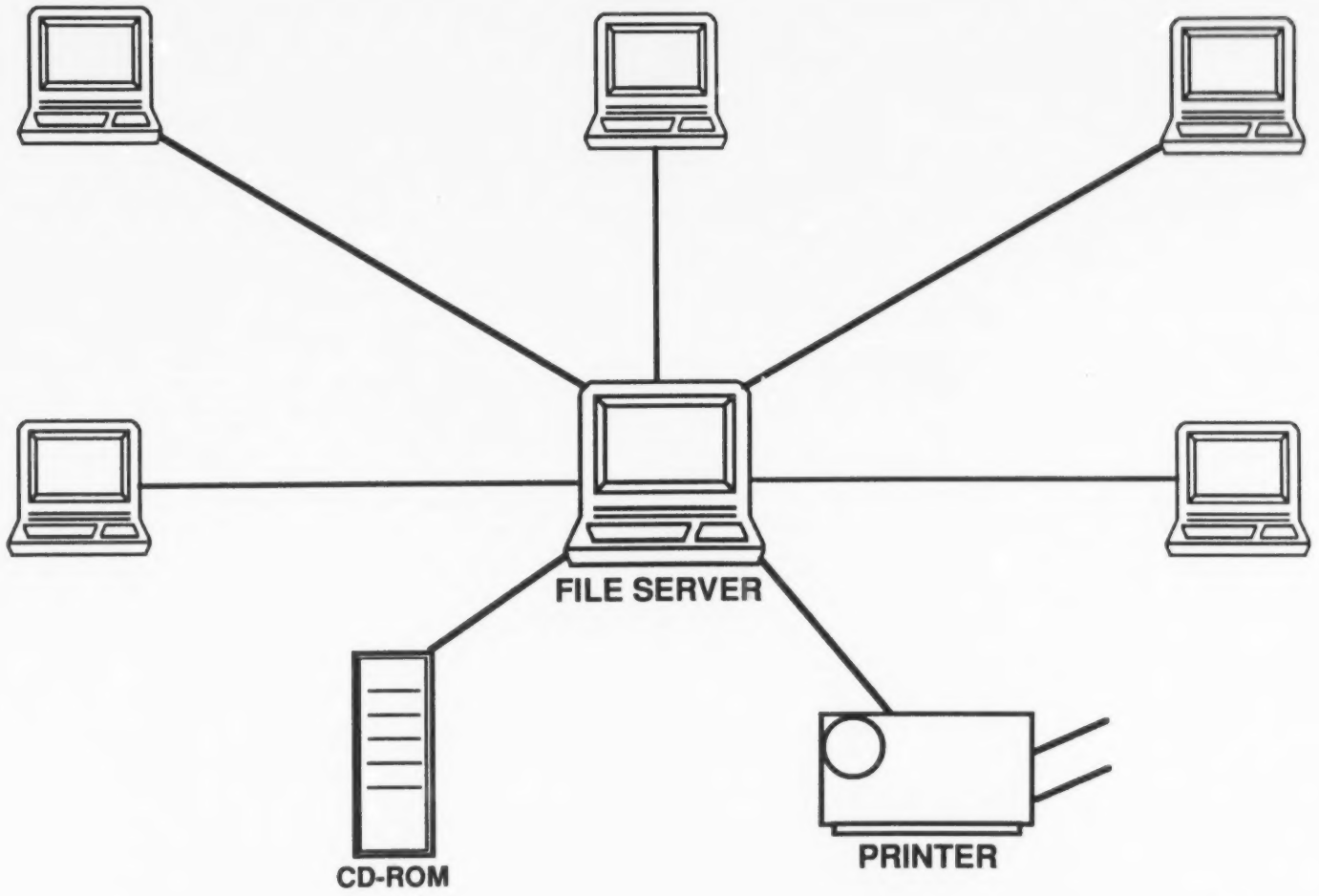
* = Channel to be changed.

LAN CONFIGURATION — BUS TOPOLOGY

(Used with ETHERNET)

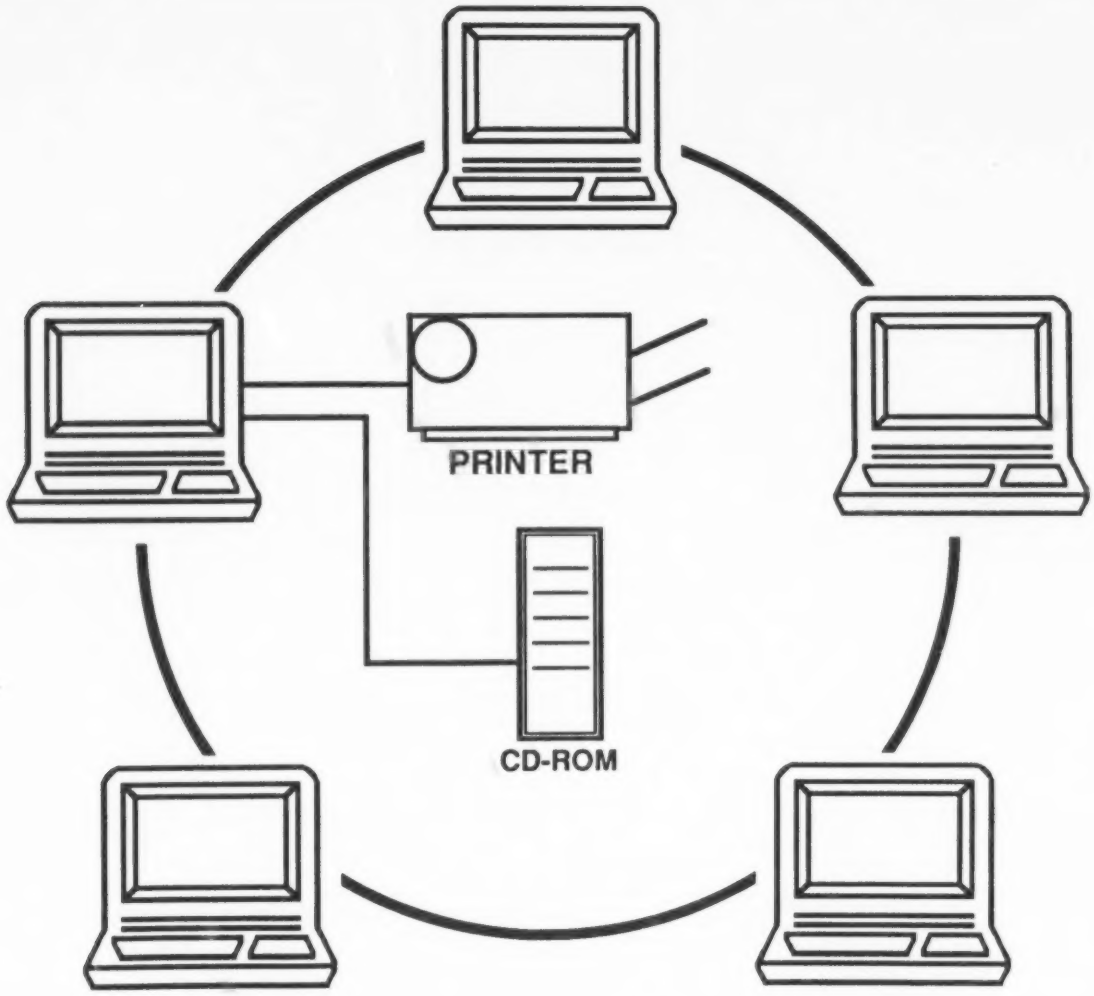


LAN CONFIGURATION — STAR TOPOLOGY

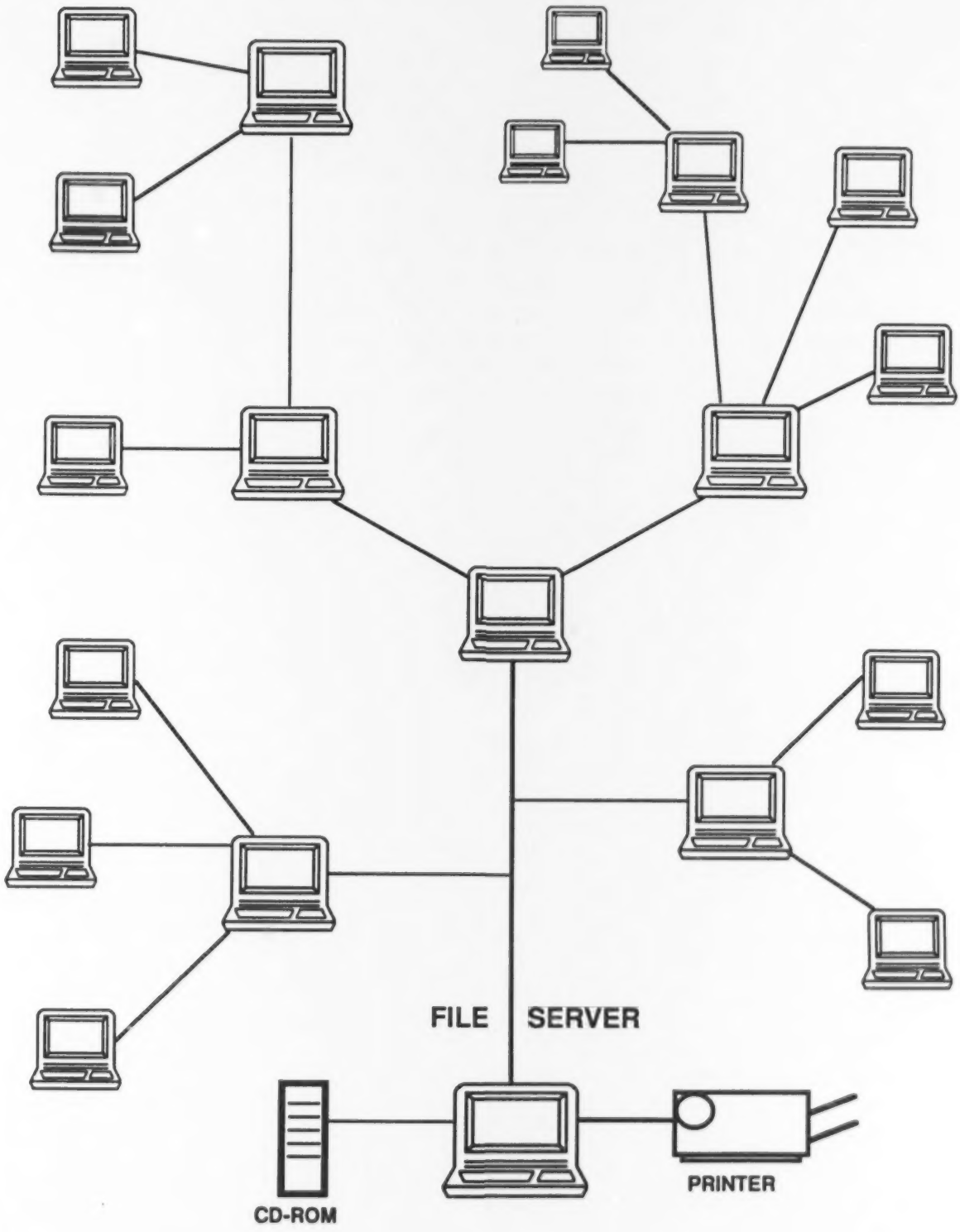


LAN CONFIGURATION

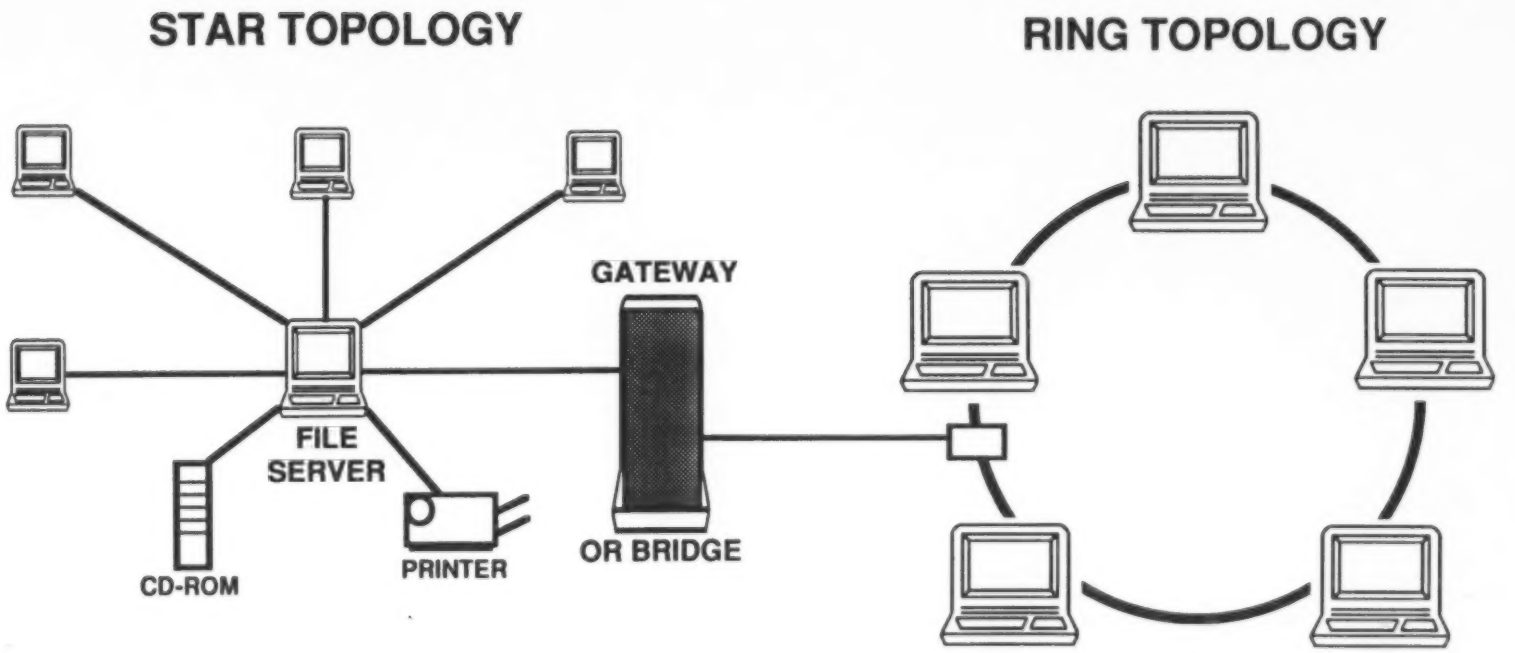
RING TOPOLOGY



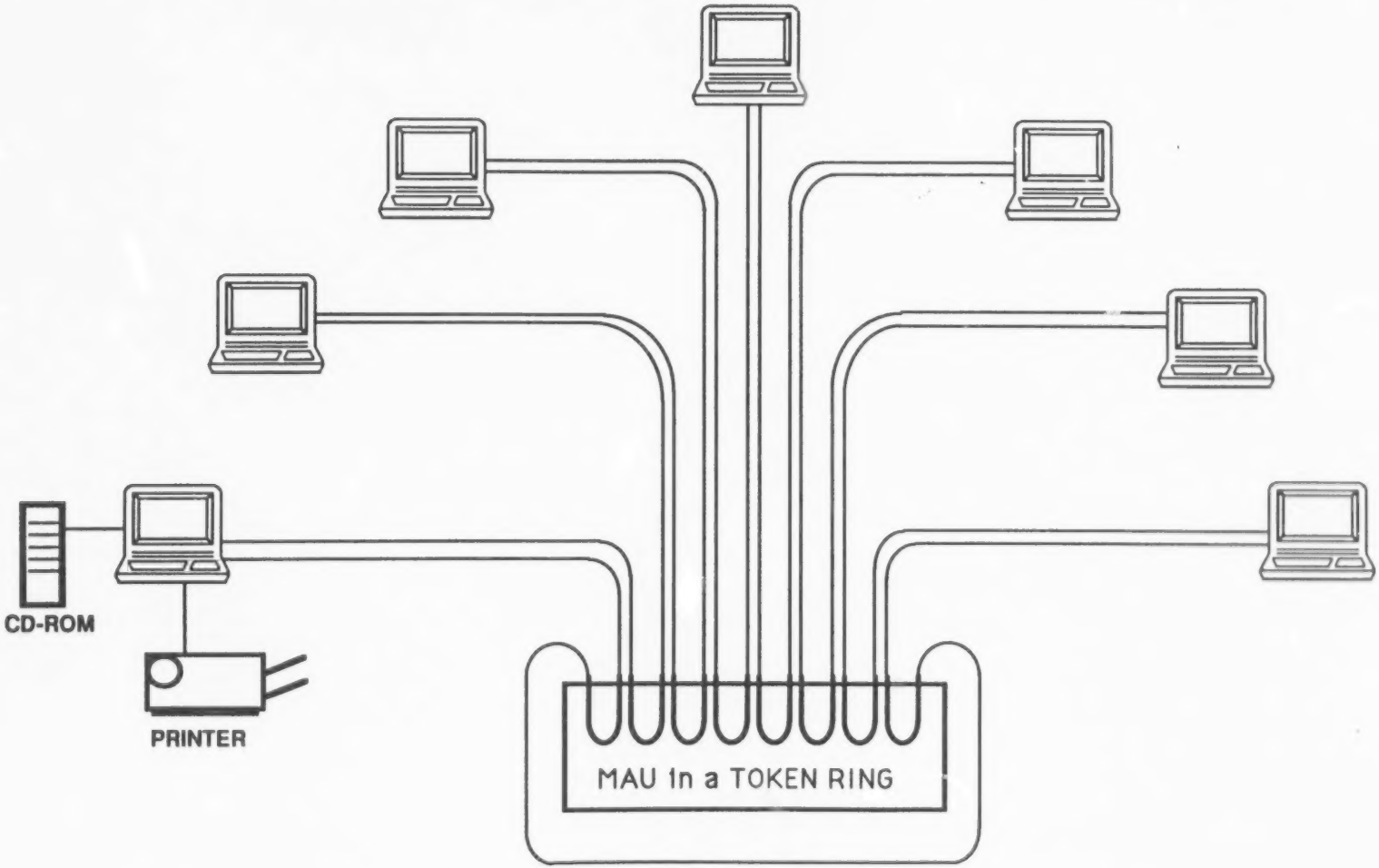
LAN CONFIGURATION — TREE TOPOLOGY



JOINING TOPOLOGIES



LAN CONFIGURATION — TOKEN RING TOPOLOGY



PHYSICAL STAR — LOGICAL RING

(Can be used with SIMS)